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## **PCVLF User's Guide**

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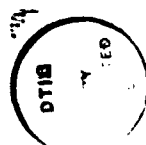
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## 1.0 INTRODUCTION

### 1.1 INTRODUCTION

PCVLF is a data acquisition program that collects, stores, and displays electromagnetic field amplitude values for a list of frequencies. PCVLF is a personal computer version of a HP-BASIC VLF data acquisition program previously used on Hewlett-Packard portable computers. If you are familiar with the earlier VLF programs you already understand the basic functions of the PCVLF program.

The earlier Hewlett-Packard system made three types of measurements: frequency list, calibration stability, and 2-kHz spectrums. Frequency list measurements were the primary measurement. Frequency list measurements collected the field strength value of 20 frequencies once every six minutes. Each 20-channel measurement cycle required about one minute. This left about five minutes of dead time between measurements. The dead time between the regular "frequency channel list measurement" was sometimes filled with a second type of measurement for each channel called "2-kHz spectrum measurements." Twice a day, at 0000 and 1200 GMT, the scheduled "frequency list measurement" was preempted by a third type of measurement called "frequency list calibration measurements." The calibration measurement was the same as the regular "frequency list measurement" (i.e., one reading of each of the 20 channels) except a test signal was switched into the antenna. Measuring the test signal helped verify the equipment was not drifting. The PCVLF program also makes these three types of measurements (i.e., frequency list, calibration, and 2-kHz spectrum). A fourth type of measurement, "200-kHz spectrums" has been added to PCVLF. This was not available in the earlier Hewlett-Packard computer programs. The PCVLF personal computer version has all the capabilities of previous programs plus many more features and enhancements.

PCVLF allows you to enter up to 60 frequencies instead of 20. Frequencies may range from VLF through HF (3 kHz to 32 MHz). Unlike previous systems, you can schedule automatic data acquisition from pop-up menus and data entry panels. Features such as realtime graphic display, data plotting, and manual measurements have also been added.

A personal computer controls the system. A Hewlett-Packard (HP) 3586C Selective Level Meter measures the signal levels. A Hewlett-Packard 59307A switch (optional) allows switching of test signals and selecting from multiple antennas. A second 59307A switch can also be added for even more signal and antenna switching possibilities. The PCVLF program runs on any IBM AT compatible personal computer that contains a National Instrument's GPIB-AT interface card.

PCVLF provides a variety of instrument control and data display options. Yet it is easy to operate because of the menu organization and use of default values. This

manual is a user's guide for understanding the PCVLF data acquisition program. Use this manual to supplement hands-on learning of the system. It is unlikely you will be able to learn about the measurement system without familiarity with the instrument controls and capabilities. Review the manufacturer's equipment manuals and become familiar with the operation of the instruments before trying to learn how PCVLF works. After becoming familiar with the hardware, the best method of learning the menu organization, capabilities, and operating procedures of PCVLF is using it.

This "user's guide" is organized to assist with both hardware and program installation and it supplements hands-on learning of system operation. Immediately following this introduction is a brief description of the program specifications. The specifications section lists the types of measurements and their limitations.

Section 2.0 contains installation instructions. It includes a list of requirements, step-by-step instructions, and details for setting up the equipment and loading the software.

Section 3.0 discusses the operation of the PCVLF program. It outlines methods for verifying correct installation and checking the signal-to-noise of the site. It describes procedures for choosing frequencies, measurement format, and schedules for data acquisition. Section 3 also contains instructions for collecting and plotting data.

Section 4.0 is a functional description of the system. It discusses the interrelationships of the instruments, computer, and software. This section explains the capabilities and limitations of each type of measurement. It also outlines the contents of the data disk files, and system options and error handling capabilities.

Section 5.0 is an abbreviated instruction set. This, along with the appendix of wiring diagrams, is useful as a checklist to those already familiar with the system installation and operation.

## **1.2 SPECIFICATIONS**

### **Equipment Required**

**COMPUTER:** IBM AT compatible with CGA, EGA, or VGA graphics, one available expansion slot, and MS-DOS operating system version 3.0 or higher

**SELECTIVE LEVEL METER:** Hewlett-Packard model 3586C

**HPIB INTERFACE:** National Instruments model AT-GPIB interface card

**HPIB CABLE:** one meter HPIB cable, Hewlett-Packard 10833A (or equivalent)

### **Optional Equipment (Application Dependent)**

**RF SWITCH:** Hewlett-Packard model 59307A VHF Switch, a computer controllable dual four-position switch

INPUT DEVICE: user determines antenna, preamplifier, power supply, filters, etc.

### **Types Of Measurements**

**Frequency List Measurements.** Before PCVLF can collect data for the first time, the user must define a frequency list and set the measurement conditions. After setup, the user can start automatic data collection at any time from the main menu. Data acquisition begins with PCVLF setting up the realtime graphics display. PCVLF then monitors the computer's clock waiting to take a measurement until the time defined by the user. Then the program sets up the instruments for measuring the signal amplitude of first frequency in the list. After taking one amplitude reading, PCVLF sets the instruments for the next frequency in the list. The process continues until PCVLF reads the signal amplitude of each channel in the list. When finished, the computer stores the data to disk, and waits for the next measurement interval. The process continues until the disk is full or the user stops the program.

HP 3586C instrument settings for "Frequency List Measurements": low distortion, autoscale, dbv units, instrument calibration before measurement.

User definable conditions (defaults in parenthesis): number of measurements (20 channels), measurement interval (6 minutes), averaging (avg on), bandwidth (BW-400 Hz), range (10 dB), input termination (50 ohms).

**2-kHz Spectrum Measurements.** 2-kHz spectrums are an optional supplement to the regular "frequency list measurements." If selected, the program takes a spectrum (2-kHz span, 25-Hz steps, 20-Hz bandwidth), of each channel in the frequency list four times per day. Spectrum measurements immediately follow the regular "frequency list measurements." Each spectrum consists of 81 readings and takes about 4.5 minutes to complete. The readings normally do not interfere with the regular "frequency list measurements." Spectrums collect data during the dead time between regular measurements.

Instrument settings for 2-kHz spectrums: averaging on, 20-Hz bw, 100-db range, low distortion, autoscale, dbv units, same HP 59307A data and antenna switch positions as for "frequency list measurements."

**Calibration Measurements.** Calibration measurements are optional. The user can define any number of calibration measurements from 0 to 24 times per day. Measurements occur at the beginning of the hour and replace the regular "frequency list measurements." The measurement is similar to the "frequency list measurements" (described above) except the computer sets the Hewlett Packard 59307A switch to "Cal" switch positions instead of "Data" positions. The user designates the "Cal" and "Data" positions of the switch when defining the frequency list. A 200-kHz spectrum

measurement immediately follows the calibration frequency list measurement. Item four (below) describes 200-kHz spectrum measurements.

Predefined HP 3586C instrument settings: low distortion, dbv units, and autoscale.

User defined conditions (defaults): center frequency (100 kHz), calibration switch position (A1B1), averaging (ave off), bandwidth (BW-400 Hz), range (100 db), and termination (50 ohms).

**200-kHz Spectrum Measurements.** PCVLF measures 200-kHz spectrums as part of the automatic calibration measurements. Also, the user can manually initiate a 200-kHz spectrum to verify antenna performance. The measurement is 400 readings, 200-kHz span, 500-Hz steps, 400-Hz bandwidth, and a center frequency defined by the user.

Predefined instrument settings: low distortion, dbv units, and autoscale.

User defined conditions (defaults): center frequency (100 kHz), calibration switch position (A1B1), averaging (ave off), bandwidth (BW-400 Hz), range (100 db), and input termination (50 ohms).

**Manual Measurements.** Frequency list measurements, and 200-kHz spectrum measurements can be initiated manually by the operator.

#### **PCVLF Program Values**

Frequency Range: 1 kHz to 32 MHz (VLF – HF)

Maximum No. of Frequency Channels: 60

#### **Measurement Intervals.**

Frequency List Measurements: zero (continuous) to 24 hours (default: 6 minute interval).

2-kHz Spectrum Measurements: four times per day (every 6 hours) if selected, starting after regular “frequency list measurement” reading. Start time begins 1 hour later each day.

Calibration Measurements: zero to 24 times per day (default 2) starting on the hour. A calibration reading replaces the regular frequency list measurement that would have occurred at the start of the hour.

#### **Data Disk Usage/File Size.**

2-kHz Spectrum Files (e.g., file name SPE91234.001): (345 bytes/rec) × (No. Channels) × (4 times per day).

200-kHz Spectrums Files (e.g., file WC120200.234): 814 bytes.

Regular Frequency Channel Data (e.g., file FRE91234.001):  $[(11) + (4) \times (\text{No. Channels})] \times [\text{No. readings per day}]$ .

## 2.0 INSTALLATION

### 2.1 HARDWARE REQUIREMENTS

The figure below (figure 2-1) lists the instrumentation required to collect and display data using the PCVLF program.

Qty	Manufacturer	Model	Description
1	Hewlett-Packard	3586C	Selective Level Master
0-2	Hewlett-Packard	59307A	VHF Switch
1-3	Hewlett-Packard	10833A	HPIB Cable (1 meter)
1	IBM Compatible	PC-AT	Personal Computer
1	National Instruments	AT-GPIB	HPIB Interface Card
*	(user determined)		Antenna/Preamplifier
*	(user determined)		Preamp Power Supply
*	(user determined)		RF Cables
*	(user determined)		Data Diskettes

Figure 2-1. Equipment required.

The computer is the heart of the system. Use any IBM AT compatible computer with CGA, EGA, or VGA graphics capability. The computer is useful, even without the rest of the system. You can plot data disks and define frequencies and data acquisition criteria using only the computer. However, PCVLF requires a complete system to collect data. Data acquisition requires a computer, selective level meter, AT-GPIB interface card, and interconnecting cables. Most applications also use antennas, amplifiers, and switches to control the input to the selective level meter.

The application determines whether to use none, one, or two 59307A VHF switches. The system needs no switches if the application uses a single antenna with no calibration signal injection. One switch can be used to periodically inject a signal into the preamplifier. Installing a second 59307A switch allows more complex input configurations, such as input from several antennas.

The system requires one HPIB cable for each device controlled by the computer. The selective level meter requires one HP 10833A HPIB cable to communicate with the computer interface. Each 59307A switch requires an additional HPIB cable.

## **2.2 HARDWARE INSTALLATION**

Planning and preparation is the key to successful field measurements. Before installing a field measurement system, evaluate the suitability of the proposed sites. Thoroughly test the entire measurement system before shipping or installing. Then carefully follow the wiring diagrams and installation procedures to install the system.

### **2.2.1 Selecting a Measurement Site**

Select an appropriate location for the data acquisition system. Choose an area free of noise sources, such as motors, generators, transmitters, and power lines. The location should be accessible to the user for verifying system operation and to changing data disks. The site should shelter the equipment from temperature extremes, moisture, and physical damage. Avoid environments that may cause the instruments to drift (e.g., near a furnace, near an air conditioner, or in direct sunlight). Provide a table or other platform at a convenient height for the user. Someone might accidentally kick the instruments or bump them with a vacuum cleaner if placed near the floor. A stable 110-volt (200-watt, 2-amp minimum) ac power source must be available. Designate a power source where no one will disconnect the system power plug.

The site must provide an appropriate outdoor area for securely mounting the antenna-preamplifier. The area should be free of nearby obstructions such as trees, buildings, and electric poles. Avoid power lines, railroad tracks, generators, transmitters, automobile traffic, and other sources of electromagnetic interference. The area also should provide physical security for the antenna. Avoid locations that would leave the antenna in a pool of water after a rain storm, or that have nearby personnel traffic. Additionally, the locations must be within reach of the coax cables from the instrumentation.

### **2.2.2 Preliminary Setup**

Before shipping equipment to a field measurement site, the computer and instrumentation should be set up and tested. Do the following

1. Install the National Instruments AT-GPIB interface card into a computer expansion slot. Use the manufacturer's instructions and default settings.
2. Prepare the computer for running MS-DOS version 3.0 or higher. Install the program files (e.g., PCVLF.EXE and GPIB.COM) on the boot disk. Sections that follow give detailed software installation instructions.
3. Verify the GPIB address switch settings. Address dip switches are found on the rear panel of the 3586C selective level meter and 59307A VHF switches. The 3586C address is 16 (1110000 left to right). The address of the 59307A

VHF switch used for preamplifier calibration is 17 (0010001 top to bottom).  
If using a second 59307A, set the address to 18 (0010010 top to bottom).

4. Before transporting the system to a measurement site, verify all equipment is operating correctly and not due for calibration.

### 2.2.3 Equipment Installation

Figure 2-2 shows a typical wiring configuration for systems using one antenna and one HP 59307A switch. In this example, the system uses one 59307A dual switch. The switch injects a calibrated signal into the preamplifier to track gain stability. The signal comes from the "Fo" output jack on the HP 3586C rear panel. The diagram shows the two sections (A and B) of the switch connected in series. This maximizes isolation of the calibration signal from the antenna-preamplifier. Whenever the computer selects the 59307A switch position "A1 B1," a signal will be injected into the antenna-preamplifier. All other switch positions allow regular signal data from the antenna to be measured.

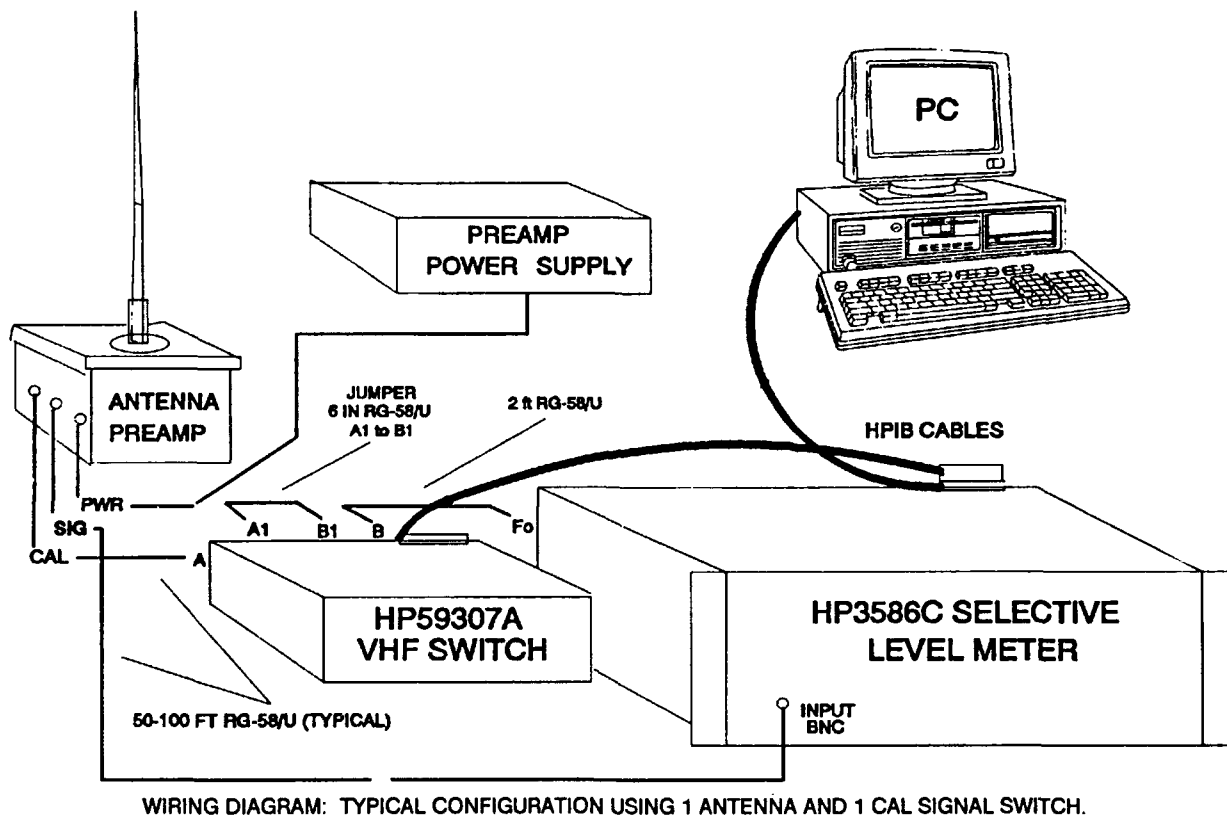


Figure 2-2. Typical wiring configuration.

Appendix A contains diagrams of other antenna and switch wiring configurations. Refer to the diagram that most fits your application. The following instructions are for installing the system:

1. Locate the equipment on a table within reach of ac power and antenna cables.
2. Connect the power cords of the instruments, personal computer, and preamplifier power supply to the ac power strip. Leave the power strip unplugged from the wall outlet while connecting the rest of the system.
3. Connect the GPIB cables. Connect a GPIB cable from the computer interface card to the GPIB connector of 3586C selective level meter rear panel. If using a 59307A switch, connect a GPIB cable from the 3586C rear connector (piggy-back) to the GPIB connector on the rear panel of the 59307A VHF switch. If using a second 59307A switch, connect a GPIB cable from rear 3586C to 59307A VHF switch.
4. Mount the antenna-preamplifier at a suitable location. Connect the three rf cables (signal, calibration, and dc power) to antenna-preamplifier.
5. Connect the "signal" cable from the antenna-preamplifier to the input BNC connector on the front-panel of the 3586C selective level meter. Depending on the type of installation, this connection may be made through a 59307A switch. See appendix A for some possible wiring configuration examples.
6. Connect the "calibration" cable (if used). If using a 59307A VHF switch for preamplifier calibration signal injection, complete this step. Connect a 2-foot BNC cable from the "Fo (0-32 MHz)" output connector on the rear panel of the 3586C to the 59307A VHF switch "A" BNC connector. Connect the "calibration" cable from the antenna-preamplifier to the appropriate BNC connector on the rear of the 59307A VHF switch. For example, connect to "B" or "1" for first antenna, "2" if second antenna used, etc.
7. Connect "dc power" cable from antenna-preamplifiers to dc power supplies.
8. Turn the system on and verify satisfactory operation. Check whether the 3586C signal and noise levels are satisfactory. Verify the computer does not radiate unwanted noise into the antenna or 3586C. Do this by comparing levels with the computer turned on and off. If noise is a problem, the antenna or computer may have to be moved.

## **2.3 SOFTWARE REQUIREMENTS**

The operating system for all programs is MS-DOS version 3.0 or higher. Figure 2-3 shows a listing of program files for a typical hard disk installation. The main directory

contains the AUTOEXEC.BAT and CONFIG.SYS files. The PCVLF subdirectory contains the remaining files. The main program, PCVLF.EXE, uses GPIB interface commands from the driver file GPIB.COM. GPIB.COM must be loaded by the CONFIG.SYS file when booting the computer. For the system to start automatically and restart after power failures, the AUTOEXEC.BAT file must execute the PCVLF program. To collect data, PCVLF requires that the MS-DOS boot disk (usually a hard disk) contain the files PCVLF.EXE, CONFIG.SYS, GPIB.COM, and AUTOEXEC.BAT. All other necessary program files, such as CUR\_CTRL.CFG, CUR\_SETS.CFG, and SITEINFO can be created by the PCVLF.EXE program during normal operation.

---

```
C:\> Dir
      PCVLF <DIR>
      AUTOEXEC.BAT
      CONFIG.SYS

C:\PCVLF\> Dir
      GPIB.COM
      PCVLF.EXE
      CUR_CTRL.CFG
      CUR_SETS.CFG
      SITEINFO
```

---

Figure 2-3. Program disk files.

## 2.4 SOFTWARE INSTALLATION

The PCVLF program files should be installed on the system boot drive (usually drive A or C). For most applications, the computer boots from a hard disk, and the hard disk contains the PCVLF program files. Whether the installer loads the *program files* on a hard disk or floppy disk has no bearing on *data file* storage. Users often choose to have data files stored to floppy while running program files from a hard disk. The following sections describe the setting up of the program files for either hard disk or floppy disk operation. Refer to the section that fits your application.

### 2.4.1 Preparing a Hard Disk

The PCVLF master program disk can be installed on a hard disk. If the computer boots from a hard disk, do the following:

1. Make a directory for the PCVLF files on the hard disk (drive C in this example).

To make the directory use the DOS command

```
MD C:\PCVLF
```

2. Copy the files PCVLF.EXE and GPIB.COM to the hard disk. Use the DOS COPY command. For example

```
COPY A:\PCVLF.EXE C:\PCVLF\PCVLF.EXE  
COPY A:\GPIB.COM C:\PCVLF\GPIB.COM
```

3. Edit the CONFIG.SYS file to load GPIB.COM, the interface device driver. Use MS-DOS EDLIN or any other text editor to add the following text statement to the file:

```
DEVICE=C:\PCVLF\GIPB.COM
```

4. Edit the AUTOEXEC.BAT file to run the PCVLF program. Use MS-DOS EDLIN or any other text editor. PCVLF will run automatically upon boot-up by adding the following text as the last statement to the file:

```
CD C:\PCVLF  
PCVLF
```

Figure 2-4 shows a sample listing of an AUTOEXEC.BAT file from a hard disk. Figure 2-5 shows a CONFIG.SYS file listing.

---

```
ECHO OFF  
PATH = C:\DOS;C:\BIN  
PROMPT = $e[32m$p$e[31m$g$e[1;36;40m  
CD C:\GRAFPLUS  
GRAFLASR =1  
CD C:\PCVLF  
PCVLF
```

---

Figure 2-4. Hard disk AUTOEXEC.BAT file.

---

```
BREAK=ON
BUFFERS=20
FILES=40
FCBS=15,15
SHELL=C:\COMMAND.COM /P /e:512
DEVICE=C:\DOS\ANSI.SYS
DEVICE=C:\PCVLF\GPIB.COM
DEVICE=C:\DOS\VDISK.SYS 2560 128 64 /e
```

---

Figure 2-5. Hard disk CONFIG.SYS file.

#### 2.4.2 Preparing A Floppy Disk

To run the program from a floppy disk drive, a program disk must be prepared. Use a backup copy of the PCVLF master program disk. If customizing your own program disk, complete the following steps:

1. Format the disk as a system boot disk. Place a blank disk in drive A. Then use the DOS command

```
FORMAT S: /S
```

2. Insert the master disk in drive B and copy the following files

```
COPY B:\GIPB.COM A:
COPY B:\PCVLF.EXE A:
COPY B:\AUTOEXEC.BAT A:
COPY B:\CONFIG.SYS A:
```

The AUTOEXEC.BAT file for a floppy driven system should contain the following statements:

```
PROMPT = $P$G
PCVLF
```

The CONFIG.SYS file for a floppy disk operated system should contain the following statements:

```
BREAK=ON  
BUFFERS=20  
FILES=40  
FCBS=15,15  
DEVICE=GPIB.COM
```

## 3.0 RUNNING THE PROGRAM

### 3.1 GETTING STARTED

There are two ways to start an installed PCVLF program. When turning the computer on, PCVLF will start automatically if installed to do so. Automatic start-up occurs only if the installer configured the AUTOEXEC.BAT file to execute the PCVLF program. The main menu (figure 3-1) will appear when the computer finishes booting. The second start-up method runs PCVLF from a MS-DOS keyboard command. To run PCVLF from the keyboard, first have the computer operating in the directory containing the PCVLF program files. Then, at the MS-DOS prompt (e.g., A:>), type the command

#### PCVLF

PCVLF starts by displaying the main menu (figure 3-1). The only exception is after abnormally halting the program (e.g., power failures) during data collection. If interruption of data acquisition occurred, the program will attempt to resume the data collection mode instead of displaying the main menu. If the computer attempts data collection, you can restore the main menu by pressing the *Escape* key. If an error message appears, follow the instructions on the display. To exit the program use the *Quit—Exit to DOS* menu option or press *Escape*.

#### 3.1.1 Main Menu

The main menu offers seven options. The first three options establish the conditions for future data acquisition. Item four initiates data collection. The next two options are for evaluating data quality. The last menu option exits to MS-DOS.

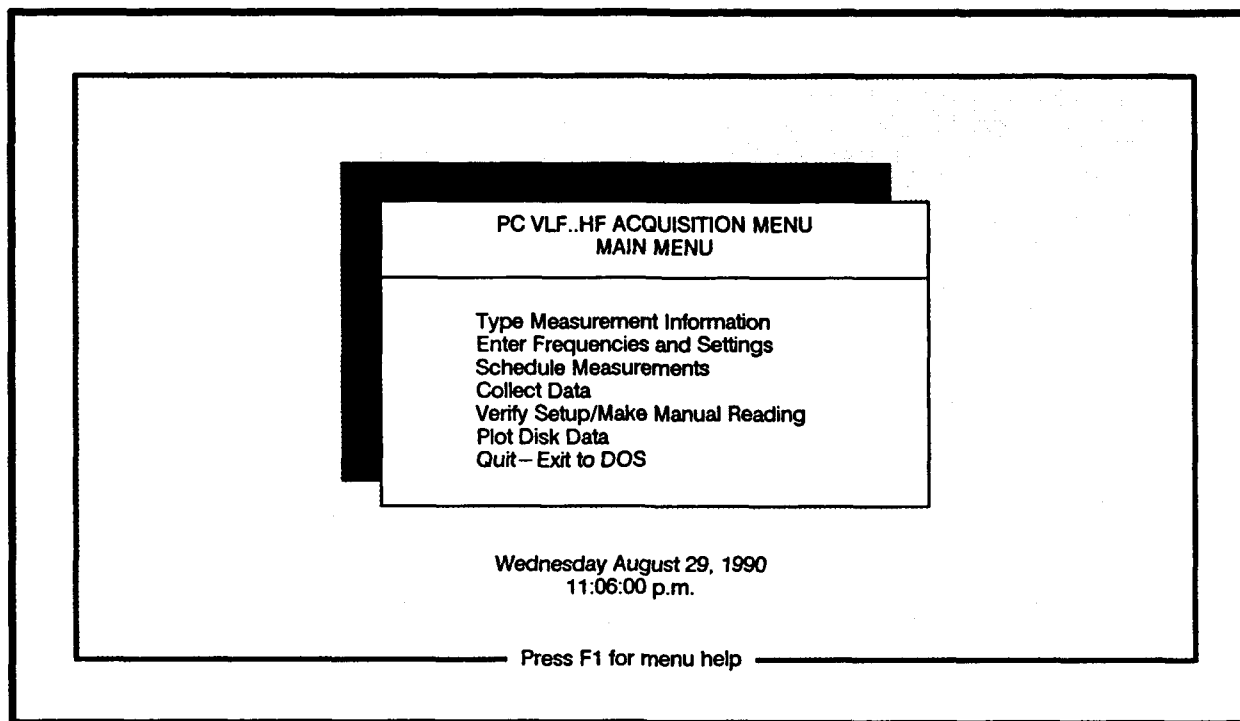


Figure 3-1. Main menu.

The first item, *Type Measurement Information*, is simply a primitive word processor. It allows you to type general text information to a file called "SITEINFO." Use this feature to add supplemental information to be stored with the data files during data acquisition. For example, you might enter site location, preamplifier type, cable length, and serial numbers. When you finish typing, PCVLF stores the SITEINFO text file. During data acquisition, PCVLF copies the SITEINFO file to each data disk.

The second menu item, *Enter Frequencies & Settings*, establishes the frequency list, switch positions, and selective level meter settings for data collection.

The third menu item, *Schedule Measurements*, sets the time intervals of the measurements, determines whether VHF switches will be used, and selects channels for the realtime graphics display.

When you complete the first three menu items, the program is ready for the *Collect Data* option. Selecting this option initiates automatic data acquisition under the conditions prescribed earlier.

The fifth menu choice, *Verify Setup/Make Manual Reading*, tests the operation of the equipment. Use this feature to evaluate system performance and the suitability of a measurement site. Gather signal values, noise values, and other information useful for identifying and troubleshooting system problems.

The sixth alternative, *Plot Disk Data*, allows graphic viewing of data already recorded to disk.

The final selection, *Quit—Exit to DOS*, terminates the program. Use this selection to leave the program to format new data disks, set the computer's clock, or run another program. Pressing *Escape* also exits the program.

Make a selection by pressing the key corresponding to the first letter of the menu item. Or, make a selection by using the up/down arrow keys to highlight an option, and then press the *Enter* key.

The computer date and time appear in a window below the main menu. The computer clock should be reset if the date or time is incorrect. This involves exiting the program and setting the system clock according to manufacturer's instructions. On many systems the DOS "DATE" and "TIME" commands do not permanently reset the system clock. Rebooting then causes the computer to revert to the time of system CMOS clock rather than DOS time.

## **3.2 PREPARING FOR DATA ACQUISITION**

Before collecting data, someone must first establish the measurement criteria. You must set the list of frequencies, time intervals of the measurements, switch positions, and other conditions. Also, you must create a file named "SITEINFO" if text information is to accompany the data files. The first three selections of the main menu accomplish setting the conditions for data acquisition.

### **3.2.1 Typing Measurement Information**

Supplemental information about the measurements is often helpful for clarifying the data files. A text file called "SITEINFO" accompanies the data files with any notes you may want to keep. You might enter measurement site information, such as installation date, name of site, address, person to contact, or special circumstances. You might note equipment information, such as serial numbers, cable types, or problems encountered.

During data collection the PCVLF program looks for the SITEINFO file in the current program directory. If a file by that name is present, it copies the file to the data disk whenever storing data.

The SITEINFO file can be created by any text editor, such as DOS EDLIN, WordPerfect, XTree, or SideKick. If an ASCII text word processor is not available, the text file can be created by the PCVLF program. Select the first option, *Type Measurement Information*, from the PCVLF main menu. This selection provides a crude text editor that will create a SITEINFO file.

Selecting *Type Measurement Information* will cause the instructions of figure 3-3 to appear at the top of the screen unless the SITEINFO file already exists. If the file already exists, the display will prompt you with the message, "SITEINFO file already exists—OK to OverWrite (Y or N)?" (figure 3-2). If you answer "N" any characters typed will be appended to the end of the existing SITEINFO file. If you select the default, "Y," a new file will be created.

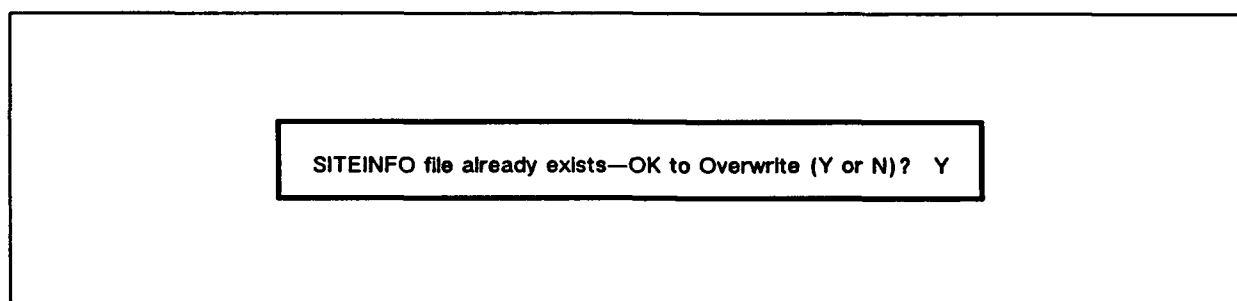


Figure 3-2. Overwrite or append SITEINFO file?

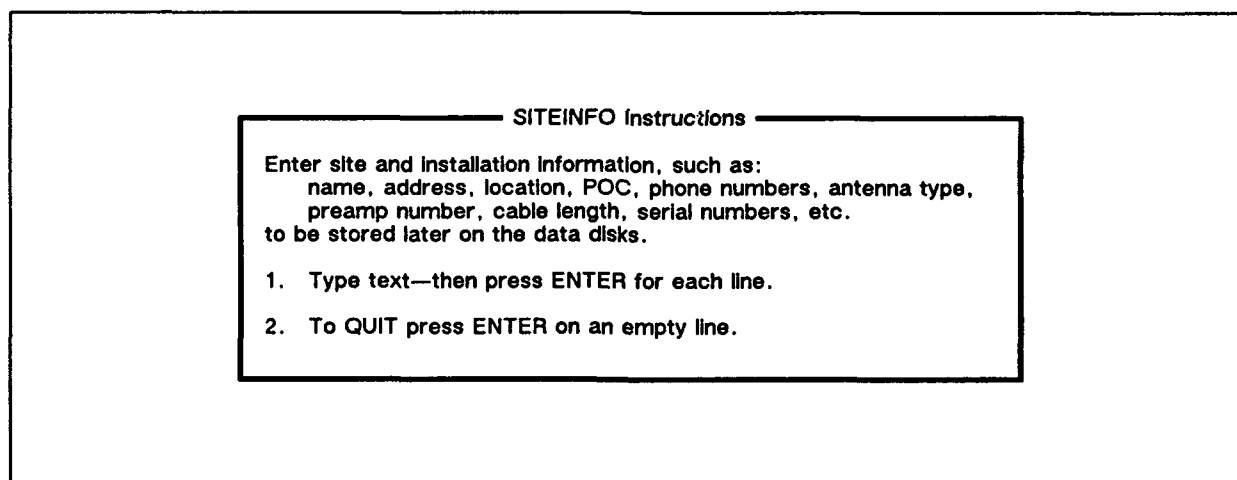


Figure 3-3. Instructions for create/append SITEINFO file.

Simply type desired information. Press *Enter* to end each line of text. When finished typing text, press the *Enter* key again on a line with no text. Any new text typed will be stored to the SITEINFO file of the current directory.

If you press *Enter* without entering new text, the program returns to the main menu. The result is as if you never selected *Type Measurement Information*. In other words, if you press *Enter* on the first line and this line is empty, then the program does not create a new SITEINFO file. Any previous SITEINFO file remains unchanged.

### 3.2.2 Entering Frequencies and Settings

The second main menu item, *Enter Frequencies & Settings*, allows selecting up to 60 frequencies for field strength measurement. Each frequency has associated instrument settings, such as bandwidth, input termination, range, averaging, and switch positions. The program predefines the initial settings. These serve as examples and default settings. If the default values are acceptable, you only need to enter the frequency values to establish the configuration files.

The configuration files, CUR\_SETS.CFG and CUR\_CTRL.CFG, must exist before data can be collected. The CUR\_CTRL.CFG file contains the measurement types and schedules. The CUR\_SETS.CFG file contains the channel list with frequency and instrument settings for each channel. If this file does not exist, the main menu selection, *Enter Frequencies & Settings*, can create the file. Select *New List* from the menu bar to create a new frequency list. If the CUR\_SETS.CFG file already exists, you can change channel frequencies and instrument settings. The menu bar (figure 3-4) allows you to display, edit, delete, append, or replace the frequencies and settings of the channel list. The following paragraphs describe how to make these changes.

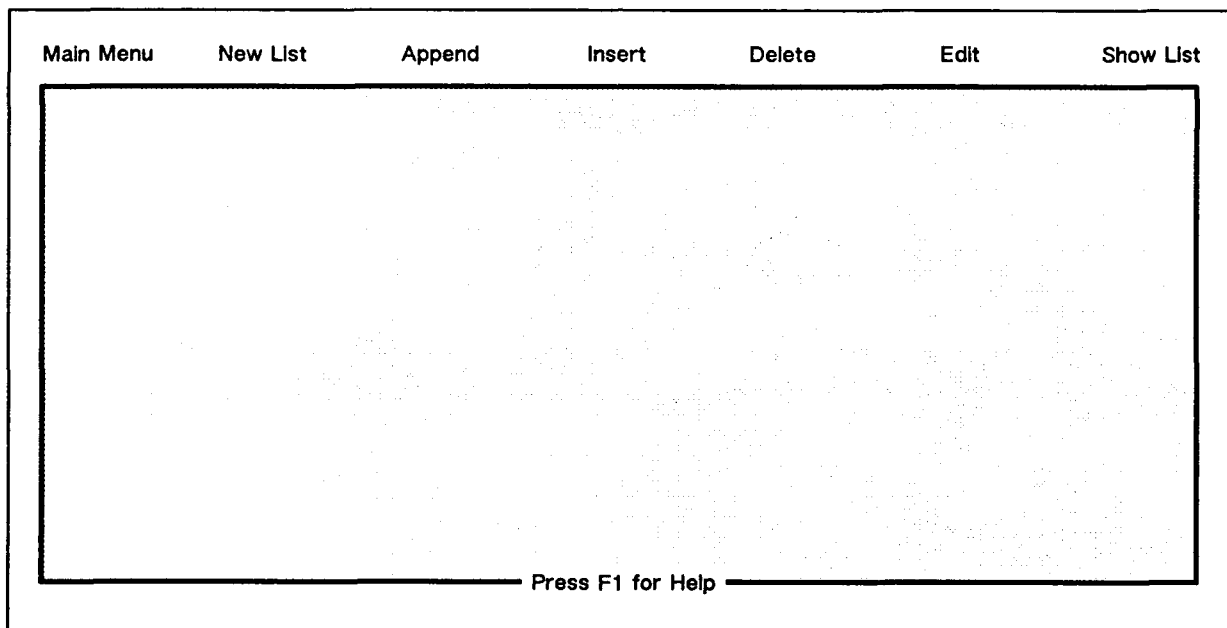


Figure 3-4. Enter frequencies and settings menu.

**3.2.2.1 Displaying Current Frequencies/Settings.** Use the *Show List* menu option from the menu bar at the top of the screen to display the current frequency list and settings (figure 3-5). Simply use the right or left arrow keys to highlight the desired option, then press the *Enter* key.

Main Menu      New List      Append      Insert      Delete      Edit      Show List								
CURRENT EQUIPMENT SETTINGS								
Ch	Freq (kHz)	BW	Term	Rng	Avg	Cal	Dat	Ant
1.	21.400	400	50	10	ON	A1B1	A3B3	A3B1
2.	23.400	400	50	10	ON	A1B1	A3B3	A1B1
3.	24.000	400	50	10	ON	A1B1	A3B3	A1B1
4.	24.800	400	50	10	ON	A1B1	A3B3	A1B1
5.	26.000	400	50	10	ON	A1B1	A3B3	A1B1
6.	28.500	400	50	10	ON	A1B1	A3B3	A1B1
7.	53.000	400	50	10	ON	A1B1	A3B3	A1B1
8.	63.000	400	50	10	ON	A1B1	A3B3	A1B1
9.	21.400	400	50	10	ON	A1B1	A3B3	A1B1
10.	63.000	400	50	10	ON	A1B1	A1B1	A1B1
Esc = quit, PgUp   PgDn   Home   End = scroll pages								

Figure 3-5. "Show List" menu choice.

The *PgUp*, *PgDn*, *Home*, and *End* keys provide viewing information when there is too much to fit on one screen. Pressing the *Escape* key will return you to the previous menu bar. Pressing *Escape* a second time will return you to the main menu.

**3.2.2.2 Creating a New Frequency List.** The *New List* option should be selected if a current frequency list does not exist or if you desire to replace it with a new list. Select *New List* by using the arrow keys to highlight the option, then press the *Enter* key.

The *New List* selection will cause either a data entry panel (figure 3-6) to appear, or if a CUR\_SETS.CFG file already exists, a warning message will appear. If warned that the file exists, you must respond to the question, "Continue anyway?" Answer by entering "N" to return to the menu bar. Press "Y" or *Enter* to display the data entry panel for the first channel.

When the data entry panel (figure 3-6) appears, PCVLF is ready for you to enter a frequency. Enter the desired frequency in kilohertz. Then press *Enter* to accept the frequency, or press *Escape* to exit without changes.

Main Menu	New List	Append	Insert	Delete	Edit	Show List
-----------	----------	--------	--------	--------	------	-----------

EDIT—CHANNEL 1

HP3586C settings:

Frequency [ ..... ] kHz

Termination [50] ohms

Averaging [ON]

Bandwidth [400] Hz

Range [10] dB

HP59307A Calibration Switch Settings:

CAL Position [A1] [B1]      DATA Position [A3] [B3]

HP59307A Antenna Switch Settings:

DATA and CAL Position [A1] [B1]

Enter Frequency (range 1 to 32000 kHz)

---

Key Definitions

Ins, Del, Bksp, Lt/Rt arrow = edit

Tab, ShftTab, Ctrl-Lt/Rt arrow, Up/Dn arrow = cursor move

F10 = accept entry, Esc = quit

TOTAL CHANNELS IN LIST = 0

Figure 3-6. Create new list.

The instrument settings can be changed by using the cursor keys to move the highlighted area to the desired field. The following keys control the cursor: *Tab*, *Shift-Tab*, *Ctrl-Left Arrow*, *Ctrl-Right Arrow*, *Up Arrow*, *Down Arrow*, and *Enter*. After highlighting the desired value, follow the editing instruction line that appears on screen for that field. Pressing the *space bar* changes many field values. After entering the desired value in the highlighted window, press a cursor control key to leave the field.

You do not need to memorize the instrument settings. Only valid entries appear on the data entry panel. For example, after highlighting the "Bandwidth" field of a frequency entry panel, pressing the *space bar* cycles the display through the valid entries (i.e., 20-, 400-, and 3100-Hz bandwidth). This avoids requiring the user to remember what values to enter.

When satisfied with the frequency and other settings, press the *F10* key to accept the data entry panel. The next data entry panel will appear for editing. Repeat the procedure until the desired channel list is complete. The bottom portion of the display window shows the total number of frequencies (channels) entered. When finished making entries, press *Escape*. An opportunity to save the changes will be given, and then control will return to the menu bar. Pressing *Escape* again will restore the main menu.

**3.2.2.3 Changing Instrument Settings.** The previous section described how easy it is to enter and change instrument settings. Simply highlight the desired field. Then edit the contents. This section gives further explanation of the settings. It discusses how the instrument settings affect data acquisition.

The computer uses the PCVLF.EXE program to control the HP 3586C Selective Level Meter and up to two HP 59307A VHF Switches. Some 3586C settings (e.g., dbv units, AutoScale, Low Distortion, and Auto Cal) are preset by the program and cannot be changed. You may change many of the other instrument settings. The 3586C frequency, bandwidth, input termination, precision range, and value averaging can be customized for each channel. Change settings as desired with the cursor and editing keys. Refer to the 3586C Operation Manual for explanations of the settings and how they affect your measurements.

Besides controlling the selective level meter settings, the program allows signal switching with a 59307A VHF Switch. The switch can be used to apply a signal periodically into the antenna-preamplifier to monitor stability. It also can select from multiple input antennas. It is possible to use one switch for both antenna switching and signal injection. The 59307A is actually two switches in one box, each having four positions. Sometimes, you might desire a separate switch for antenna selection. Separating the switches isolates the calibration injection signal from the antenna return signal. The PCVLF program can control none, one or two 59307A switches, depending on your choice.

The switch positions in the program are irrelevant if a switch is not going to be used during data collection. You designate which 59307A switches are active. Activate switches with the *Measurement Format* main menu option (described later in section 3.2.3, Scheduling and Controlling Measurements). If "calibration measurements" are not to be selected, the "CAL" switch positions are irrelevant and may be ignored. In other words, if you set "Cal Readings per Day" to zero times a day the "CAL" positions have no meaning to the program.

If 59307A switches are to be used, it is usually wise to hand draw a wiring diagram of the switches. Then make a table of switch settings for each channel in the frequency list. The switch listed first on the data entry panel, the calibration switch, has separate settings for the "CAL" measurement and "DATA" measurement modes. The other switch, the antenna switch, uses the same position whether collecting regular "DATA" or injecting "CAL" signals. Thus, the hand-drawn chart should have two columns for the calibration switch, and one column for the antenna switch. Figure 3-5 shows a list of frequencies and corresponding switch settings.

After making a switch position table, it is easy to enter the values on the data entry panel. Use the cursor keys to highlight a field that designates switch settings, then use

the *space bar* to edit the field. The *space bar* will cycle the menu through the four possible selections.

When finished editing a field, press a cursor control key to edit another field, or press the *F10* key to accept the values of the data entry panel.

**3.2.2.4 Adding New Channels to the List.** Choose the *Append* option to add frequencies to the end of an existing channel list. The data entry panel will appear (figure 3-6). However, the "TOTAL CHANNELS IN LIST = " at the bottom of the screen will not equal zero. When adding channels to an existing list, the display will show the number of frequencies already entered. Follow the same procedure described in the preceding paragraph to add new frequencies. After entering the desired values, press the *F10* key to accept the entry and advance to the next window. The display, "TOTAL CHANNELS IN LIST = " will be incremented to the new number of channels in the list. When finished adding new channels, press *Escape*. The program will ask, "Save Now (Y or N): Y." Press either the *Enter*, *Escape* or "Y" keys, and the new channels will be added to the list. Press the "N" key and the program will ignore all the edits, return to the menu bar, and keep the original frequency list.

**3.2.2.5 Inserting and Editing Channels.** The *Insert* and *Edit* options require selecting a value or position from the existing list. A list menu (figure 3-7) displays the existing list. Use the cursor keys (i.e., *Up Arrow*, *Down Arrow*, *Home*, *End*, *PgUp*, and *PgDn*) to highlight the choice, then press *Enter* to complete the selection. Accomplish editing as described in the above sections. Press the *F10* key to accept the settings. Press *Escape* to quit and return to menu bar.

**3.2.2.6 Deleting Channels from the List.** The *Delete* option allows deleting one or more frequencies from the list. The selection menu is similar to the *Insert* and *Edit* selection list (figure 3-8). Use the arrow keys to highlight the desired frequency to delete, then press the *space bar* to mark the channel for deletion. Press the *space bar* again to unmark a frequency wrongly marked for deletion. After highlighting the final channel to be deleted, press *Enter* to complete the operation. A message will appear that shows how many channels will be deleted. Answer "Y" or press *Enter* to save the changes. Answer "N" to keep the original list and ignore the deletions.

### **3.2.3 Scheduling and Controlling Measurements**

After establishing the frequency list, you should enter the measurement timing and control information. The third menu option *Schedule Measurements* of the main menu allows you to tailor a measurement scenario to your specific measurement goals.

Main Menu	New List	Append	Insert	Delete	Edit	Show List																						
<div style="border: 1px solid black; padding: 10px; margin: 0 auto; width: 80%;"> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; padding: 2px;">Ch</th> <th style="text-align: left; padding: 2px;">Freq (kHz)</th> </tr> </thead> <tbody> <tr><td style="padding: 2px;">5.</td><td style="padding: 2px;">26.000</td></tr> <tr><td style="padding: 2px;">6.</td><td style="padding: 2px;">28.500</td></tr> <tr><td style="padding: 2px;">7.</td><td style="padding: 2px;">53.000</td></tr> <tr><td style="padding: 2px;">8.</td><td style="padding: 2px;">63.000</td></tr> <tr><td style="padding: 2px;">9.</td><td style="padding: 2px;">21.400</td></tr> <tr><td style="padding: 2px;">10.</td><td style="padding: 2px;">63.000</td></tr> <tr><td style="padding: 2px;">11.</td><td style="padding: 2px;">21.400</td></tr> <tr> <td style="padding: 2px; text-align: center;">&gt;</td> <td style="padding: 2px; text-align: center;">-INSERT HERE- &lt;</td> </tr> <tr><td style="padding: 2px;">12.</td><td style="padding: 2px;">23.400</td></tr> <tr><td style="padding: 2px;">13.</td><td style="padding: 2px;">24.000</td></tr> </tbody> </table> <p style="margin-top: 10px; font-size: small;">           Esc = quit — ignore selection            ENTER = quit — selection made            Up/Dn arrow = scroll         </p> <div style="border-top: 1px solid black; border-bottom: 1px solid black; padding: 2px 0; margin-top: 10px;">             ENTER SELECTION           </div> </div>							Ch	Freq (kHz)	5.	26.000	6.	28.500	7.	53.000	8.	63.000	9.	21.400	10.	63.000	11.	21.400	>	-INSERT HERE- <	12.	23.400	13.	24.000
Ch	Freq (kHz)																											
5.	26.000																											
6.	28.500																											
7.	53.000																											
8.	63.000																											
9.	21.400																											
10.	63.000																											
11.	21.400																											
>	-INSERT HERE- <																											
12.	23.400																											
13.	24.000																											

Figure 3-7. Menu for "Insert" a new frequency to list.

Main Menu	New List	Append	Insert	Delete	Edit	Show List																						
<div style="border: 1px solid black; padding: 10px; margin: 0 auto; width: 80%;"> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; padding: 2px;">Ch</th> <th style="text-align: left; padding: 2px;">Freq (kHz)</th> </tr> </thead> <tbody> <tr><td style="padding: 2px;">1.</td><td style="padding: 2px;">21.400</td></tr> <tr><td style="padding: 2px;">2.</td><td style="padding: 2px;">23.400</td></tr> <tr><td style="padding: 2px;">✓ 3.</td><td style="padding: 2px;">24.000</td></tr> <tr><td style="padding: 2px;">✓ 4.</td><td style="padding: 2px;">24.800</td></tr> <tr><td style="padding: 2px;">✓ 5.</td><td style="padding: 2px;">26.000</td></tr> <tr><td style="padding: 2px;">✓ 6.</td><td style="padding: 2px;">28.500</td></tr> <tr><td style="padding: 2px;">7.</td><td style="padding: 2px;">53.000</td></tr> <tr><td style="padding: 2px;">✓ 8.</td><td style="padding: 2px;">63.000</td></tr> <tr> <td style="padding: 2px; text-align: center;">&gt;</td> <td style="padding: 2px; text-align: center;">9. 21.400 &lt;</td> </tr> <tr><td style="padding: 2px;">10.</td><td style="padding: 2px;">63.000</td></tr> </tbody> </table> <p style="margin-top: 10px; font-size: small;">           Esc = quit — ignore selection            ENTER = quit — selection made            SpcBar = mark list            Up Dn PgUp PgDn Home End = scroll         </p> <div style="border-top: 1px solid black; border-bottom: 1px solid black; padding: 2px 0; margin-top: 10px;">             ENTER SELECTION           </div> </div>							Ch	Freq (kHz)	1.	21.400	2.	23.400	✓ 3.	24.000	✓ 4.	24.800	✓ 5.	26.000	✓ 6.	28.500	7.	53.000	✓ 8.	63.000	>	9. 21.400 <	10.	63.000
Ch	Freq (kHz)																											
1.	21.400																											
2.	23.400																											
✓ 3.	24.000																											
✓ 4.	24.800																											
✓ 5.	26.000																											
✓ 6.	28.500																											
7.	53.000																											
✓ 8.	63.000																											
>	9. 21.400 <																											
10.	63.000																											

Figure 3-8. Menu for "Delete" channel(s) from list.

From the main menu press the "S" key or highlight the *Schedule Measurements* option and press *Enter*. The menu bar will appear with options *Main Menu*, *Meas Format*, and *200-kHz Spec*. Use the arrow keys to highlight *Meas Format* and then press the *Enter* key. Figure 3-9 shows an example of the *Meas Format* data entry panel.

Main Menu	Meas Format	200 kHz Spec
<div style="border: 1px solid black; padding: 10px; margin: 10px auto; width: 80%;"> <p style="text-align: center;">- Change Measurement Control Settings -</p> <p>Measurement Interval: [..... 6] [minutes]</p> <p>Cal Readings per Day: [...2]</p> <p>Do Spectrums (2 kHz)? [YES]</p> <p>Data Disk Drive Path: [B:\]</p> <p>Plot Channels - Ch A: [...9] Ch B: [19]</p> <p>Graph Scale (dB) max: [... 2] min: [... 22]</p> <p style="text-align: center;">- Assign Optional HP-IB Equipment: HP59407A Switches -</p> <p>Cal Signal Switch (adr 17)? [YES]</p> <p>Antenna Select Sw (adr 18)? [NO]</p> <p>[ Enter Time (range: 0 seconds to 1440 minutes) ]</p> <p style="text-align: center;">Enter Frequency (range 1 to 32000 kHz)</p> <hr style="width: 50%; margin: 10px auto;"/> <p style="text-align: center;">Key Definitions</p> <p style="text-align: center;">Ins, Del, Bksp, Lt/Rt arrow</p> <p style="text-align: center;">Tab, Shft-Tab, Ctrl-Lt, Ctrl-Rt, Up, Dn = cursor move</p> <p style="text-align: center;">F10 = accept entry, Esc = quit, F2 = show freqs</p> </div>		

Figure 3-9. Menu to schedule measurement format.

**3.2.3.1 Setting Measurement Repetition Interval.** The "Measurement Interval" field of the data entry panel determines when a measurement cycle of the frequency channel list will be made. Enter "0" minutes or seconds for continuous cycling through the channel list. Enter any interval other than zero and the program will synchronize measurements to the computer's realtime clock. Each measurement cycle will begin on an even multiple of the time interval you enter.

It is up to you to select measurement intervals that make sense. Each reading takes about three seconds in the averaging mode and about one second without averaging. 2-kHz spectrums take about four to five minutes to complete. Consider measurement times carefully or the program may not respond as expected. For example, a 6-minute measurement interval makes sense when you want "2-kHz spectrums" with 20 channels. Calculate as follows

$$((3 \times 20) + 270 + 30) / 60 = 6 \text{ minutes.}$$

That is, 3 seconds per reading per channel, times 20 channels, plus 4.5 minutes spectrum measurement time, plus 30 seconds slack time for disk access equals

6 minutes. If measurement cycles overlap into the next time interval, the next reading will be skipped. For example, with 60 channels selected, it will take about 3 minutes for each measurement cycle (3 seconds times 60 channels). Selecting a 2-minute interval will actually result in a 4-minute interval. This is because the 3 minutes it takes to complete each measurement cycle will cause the next 2-minute increment to be skipped.

Also, be aware that rapidly varying signals, such as pulse and noise signals, cannot be resolved to a single reading by the HP 3586C Selective Level Meter. The program will "timeout" after 10 seconds if the instrument cannot track fast enough to make a reading. The program will store the value -999.9 dbv in place of data missed by the 10-second timeout. It should be apparent from this discussion the "1" and "3" seconds per reading are merely guidelines for estimating. Actual readings can take up to 10 seconds depending on the slope of the signal and resolution (10- or 100-dB range) you select.

**3.2.3.2 Selecting 2-kHz Spectrums.** The data collection scheme can include 2-kHz spectrum measurements of each channel 4 times per day if there is enough time allotted between each regular frequency list measurement. After highlighting the field "Do Spectrums (2 kHz)?," pressing the *space bar* will toggle the entry between "YES" and "NO." The program will display a warning and prevent answering "YES" if there is not enough time for spectrums.

The spectrum readings start on an even multiple of 6 hours immediately after the regular channel list measurement cycle. The center frequency is the value contained in the regular frequency channel list. If using a 59307A switch, PCVLF sets it to the "DATA" position. 2-kHz spectrum measurements follow every regular "frequency list measurement" cycle until recording all the spectrum channels. The start time of the 2-kHz spectrum measurement series advances 1 hour each day.

**3.2.3.3 Selecting HP 59307A Switches.** PCVLF provides a data entry panel from which you can choose whether none, one, or two HP 59307A switches will be used. The data entry panel that appears when you make the selection *Schedule Measurements* from the main menu followed by the *Measurement Format* submenu selection. The switch choices are "Cal Signal Switch (adr 17)?" and "Antenna Select Sw (adr 18)?" (see figure 3-9). Use the *space bar* to toggle the entry in the highlighted field. Zero, one, or both switches may be selected depending on your application. During data acquisition, PCVLF will ignore position settings for any switch you have made inactive. If you select a switch for use, it must be correctly connected to the system. An error message will occur when attempting data acquisition if the 59307A address (dip switch) is not correctly set.

**3.2.3.4 Selecting Data Storage Disk Drive.** PCVLF provides a data entry panel for selecting which disk drive will contain the data files. The data entry panel that appears after selecting *Schedule Measurements* from the main menu, followed by the *Measurement Format* submenu selection. From the data entry screen, use the cursor keys (i.e., *up/down right/left arrow*, or *tab* keys) to highlight the field "Data Disk Drive Path." Then use the *space bar* to select the disk drive (A-K) for data storage. PCVLF always stores data in the root directory, even when running the program from a subdirectory.

**3.2.3.5 Setting Realtime Plot Display.** During data acquisition, PCVLF displays a realtime plot of the data. Up to two channels can be plotted at a time. PCVLF provides a data entry panel (figure 3-9) for selecting which channels will be plotted and at what scale. The data entry panel appears when you select *Schedule Measurements* from the main menu and *Measurement Format* from the submenu bar. From the data entry panel, enter zero on "Ch A" or "Ch B" if only one channel is to be displayed. A zero entry on both channels will cause no data to appear on the plot. Skipping data plotting may increase data acquisition speed slightly. However, most of the time involved in data acquisition is the 3586C instrument response time.

**3.2.3.6 Selecting Calibration Measurements.** You schedule "calibration measurements" from the *Measurement Format* data entry screen. Obtain the data entry panel (figure 3-9) by selecting *Schedule Measurements* from the main menu. Then choose *Measurement Format* from the sub-menu bar. Use the arrow keys to highlight the field "Cal Readings per Day." Then enter the desired number of calibration measurements. PCVLF accepts entries ranging from zero to 24 times per day. Calibration measurements start at the beginning of the hour, so only enter values that divide evenly into 24 hours.

The calibration measurements have two parts. First, PCVLF makes a set of readings of the frequency list. This measurement set is the same as regular "frequency list measurements", except for the HP 59307A switch positions. The program uses the positions defined for "CAL" instead of "DATA" definitions. You define the equipment settings for each channel when choosing the frequency list. A 200-kHz spectrum measurement immediately follows the Calibration Frequency List Measurement. The 200-kHz spectrum also uses settings defined by you as described in the next section.

**3.2.3.7 Setting 200-kHz Spectrum Conditions.** The "200-kHz wide spectrum settings" data entry panel (figure 3-10) appears when you select *200 kHz Spec* after selecting *Schedule Measurements* from the main menu. This data entry panel allows you to set center frequency, bandwidth, input termination, db range, averaging on/off, and 59307A switch settings.

Main Menu	Meas Format	200 kHz Spec								
<div style="border: 1px solid black; padding: 10px; margin: 10px auto; width: 80%;"> <p style="text-align: center; margin: 0;"><b>200 kHz WIDE SPECTRUM SETTINGS</b></p> <p>HP3586C settings:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">Center Frequency ...100 kHz</td> <td style="width: 50%;">Bandwidth 400 Hz</td> </tr> <tr> <td>Termination 50 ohms</td> <td>Range 100 dB</td> </tr> <tr> <td colspan="2">Averaging OFF</td> </tr> </table> <p>HP59307A Calibration Switch Settings:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">CAL Position A1B1</td> <td style="width: 50%;">DATA Position A1B3</td> </tr> </table> <p>HP59307A Antenna Switch Settings:</p> <p>DATA and CAL Position A1B1</p> <p style="text-align: center; margin-top: 10px;">Enter Frequency (range 1 to 32000 kHz)</p> <hr style="border: 0; border-top: 1px solid black; margin: 5px 0;"/> <p style="text-align: center;">Key Definitions</p> <p style="text-align: center;">Ins, Del, Bksp, Lt/Rt Arrow</p> <p style="text-align: center;">Tab, Shft-Tab, Ctrl-Lt, Ctrl-Rt, Up, Dn = cursor move</p> <p style="text-align: center;">F10 = accept entry, Esc = quit</p> </div>			Center Frequency ...100 kHz	Bandwidth 400 Hz	Termination 50 ohms	Range 100 dB	Averaging OFF		CAL Position A1B1	DATA Position A1B3
Center Frequency ...100 kHz	Bandwidth 400 Hz									
Termination 50 ohms	Range 100 dB									
Averaging OFF										
CAL Position A1B1	DATA Position A1B3									

Figure 3-10. Setting 200-kHz spectrum conditions.

The center frequency can be any value from 100 to 3100 kHz. The program only accepts frequency values in 100-kHz increments. Enter the other 3586C settings and 59307A switch settings using the cursor keys in the same manner as described in preceding sections. Press the *F10* key when finished, or press *Escape* to exit without saving the entries.

The choices of switch position depend on your application and the equipment configuration. For example, the "Cal position" switch setting could be used to inject a test signal into the preamp to record system frequency response. The "Cal position" switch setting instead could select an antenna and record a spectrum of incoming signals. Calibration measurements use the "Cal" position. Manual measurements can use either the "Cal" or "Data" position.

### 3.3 MANUAL MEASUREMENTS AND CHECKING SYSTEM PERFORMANCE

The PCVLF main menu option *Verify Setup/Make Manual Reading* provides a means of checking system operation and making manual measurements. Figure 3-11 shows the menu bar. The four choices are *Main Menu*, *Test HPIB*, *Read Freqs*, and *200-kHz Spectrum*. Selecting the *Main Menu* option or pressing *Escape* exits to the main menu. The other three options are for testing equipment and making manual readings.

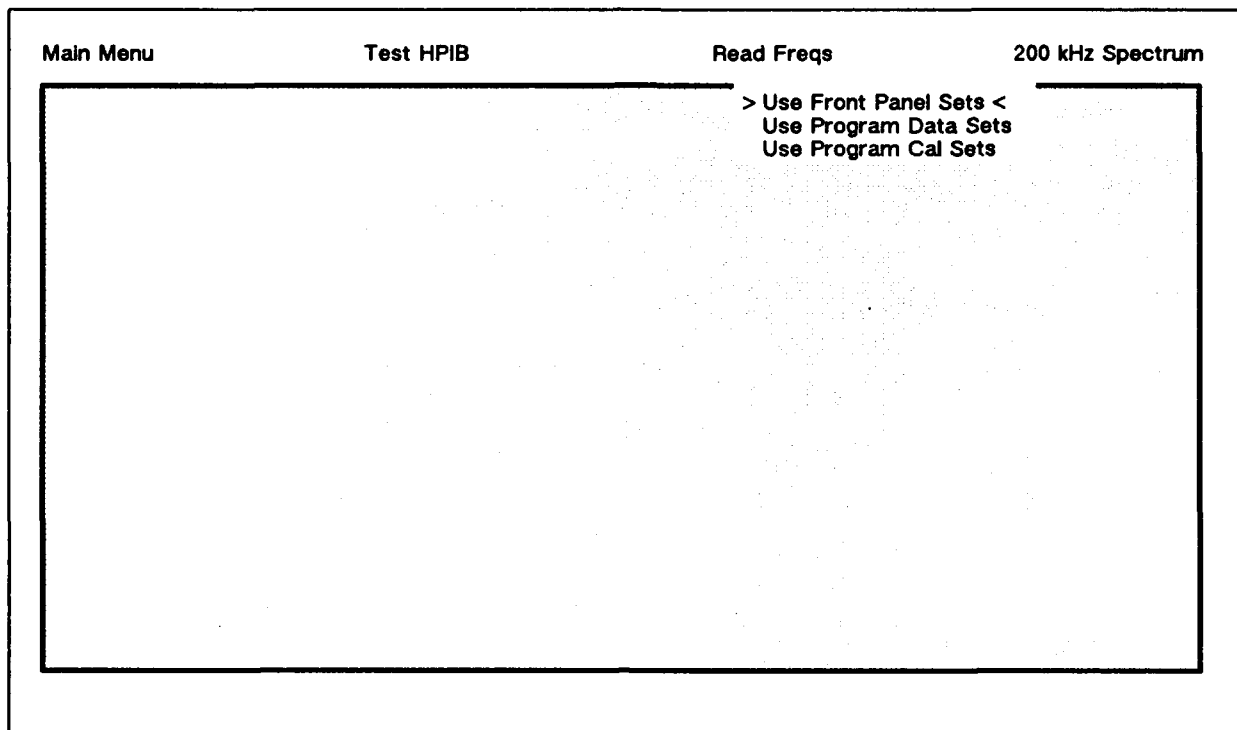


Figure 3-11. Verifying setup/making manual measurements.

### 3.3.1 Verifying Equipment Intercommunication

The *Test HPIB* option on the menu bar verifies communications between the computer and the measurement equipment. The test includes the AT-GPIB interface card, the HP 3586C Selective Level Meter, and the HP 59307A switches.

If the screen displays a communication failure warning message, check the cables and device addresses. The HPIB devices are the 3586C selective level meter, 59307A calibration switch, and 59307A antenna switch. Refer to installation section (section 2) for proper addressing of the devices.

If the computer is unable to communicate to the AT-GPIB interface board. A warning message will be displayed. Check that the National Instrument AT-GPIB board is correctly installed and the GPIB.COM driver is loaded during boot-up. The manufacturer's manual describes additional test procedures.

### 3.3.2 Manual Frequency List Measurement

The *Read Freqs* option of the menu bar offers you a chance to display a sample of the data. This option reads the amplitude and displays the value for each frequency in the channel list. Figure 3-12 shows an example of readings when *Use Front Panel Sets* selected. The values that appear on the screen are the actual ASCII characters returned

from the Selective Level Meter. When you choose *Use Program Data Sets* or *Use Program Cal Sets* options, the readings displayed are not the actual ASCII characters. The program rounds the values. The values are similar to what PCVLF stores on the disk during automatic data collection.

HP3586C readings—using front panel manual settings								
Ch	Freq	dB	Ch	Freq	dB	Ch	Freq	dB
1.	23.400	N-077.165	2.	63.000	N-049.455	3.	21.400	N-054.011
4.	63.000	N-050.616	5.	21.400	N-054.083	6.	23.400	N-075.904
7.	24.000	N-055.560	8.	24.800	N-044.865	9.	26.000	N-075.107
10.	28.500	N-072.201	11.	53.000	N-082.272	12.	63.000	N-049.880
13.	21.400	N-054.196	14.	63.000	N-050.583			
Press any key...								

Figure 3-12. Manual reading of frequency list.

### 3.3.3 Manual 200-kHz Spectrum Measurement

From the main menu select *Verify Setup/Make Manual Reading*. Then make the menu bar selection, *200 kHz Spectrum* to start a 200-kHz spectrum scan. The result will be plotted to the screen (figure 3-13). The computer makes 400 readings in 500 Hertz steps using the 400-Hertz bandwidth. You select the center frequency and plot scales. The plot is useful for evaluating site noise or signal-to-noise. It is also helpful for viewing antenna-preamplifier frequency response, and determining which stations are on the air.

The *Use Front Panel Sets* pull-down menu option allows you to manually enter any desired instrument settings, center frequency, and plotting scales. The realtime plot can be stopped at any time by pressing the *Escape* key. The *Use Program Cal Sets* pull-down menu option collects 200-kHz calibration spectrum data in the same manner as during automatic data acquisition. It uses the same center frequency, switch positions, and other settings you previously defined for automatic data acquisition. The computer collects the 400 readings before plotting begins. While collecting data, PCVLF displays

the message, "Collecting Data . . . (Esc to Quit)." If a problem prevents collecting data, the program will return to the menu. If this happens, verify equipment communications with the *Test HPIB* menu bar option. Also, verify the main menu *Schedule Measurements* options are correct.

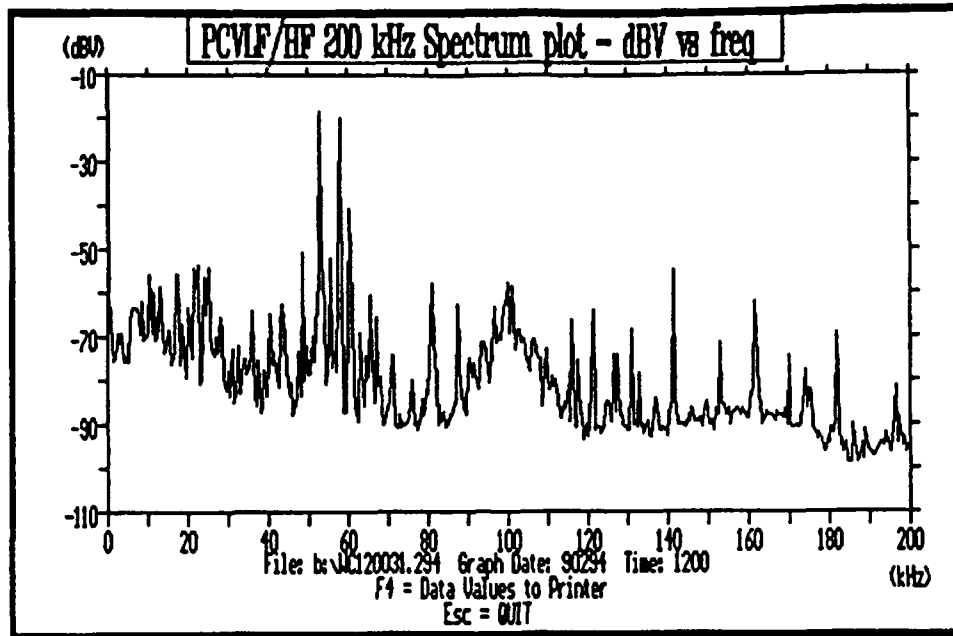


Figure 3-13. Manual 200-kHz spectrum measurements.

The pull-down menu selection *Use Program Data Sets* is similar to *Use Program Cal Sets* described above. The only difference is PCVLF uses the "Data" position instead of the "Cal" position of the 59307A calibration switch.

### 3.4 COLLECTING DATA

The fourth item on the main menu is *Collect Data*. This option initiates automatic data collection, provided the necessary setup files are present. The first three items of the main menu create the files that set the stage for data collection. The files *CUR\_CTRL.CFG* and *CUR\_SETS.CFG* contain the list of frequencies and schedule for automatic data collection. If these files exist in the current directory, the program is ready for automatic data acquisition.

#### 3.4.1 Starting Data Acquisition

Start data collection from the PCVLF main menu. Press the "C" key to invoke the automatic data acquisition mode (figure 3-14). You also can start data collection by using the arrow keys to highlight *Collect Data*, then press *Enter*.

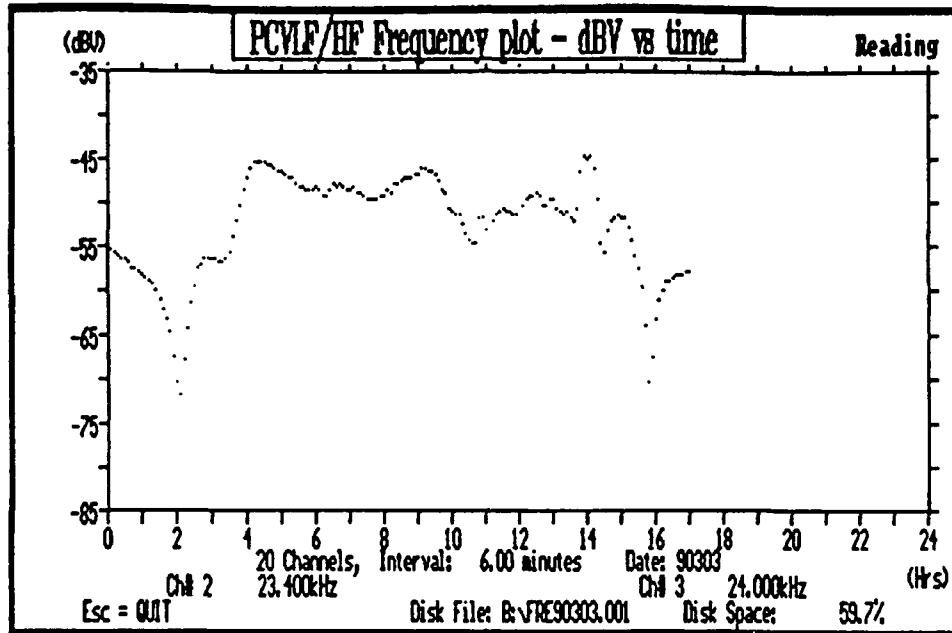


Figure 3-14. Realtime data acquisition display (CGA).

If the equipment and software installation is correct, the program will pass the equipment communication tests. Then PCVLF will draw the realtime data plotting screen. While waiting for the measurement time to begin, the upper right corner displays a reading of the computer's clock. When taking readings, the message "Reading" replaces the time display. Pressing the *Escape* key at any time will stop the data acquisition. PCVLF then updates the disk files and returns the display to the main menu.

### 3.4.2 Checking System Operation

Although the system requires no attention while collecting data, it is wise to check the program operation at least once a day. The lower right corner of the screen displays the percent of disk space remaining. You should replace the disk, or move files if the disk is nearly full. The upper right corner of the screen displays the clock reading. If the time is not within the desired tolerance, exit PCVLF (press *Escape* twice) and reset the clock. You also should observe whether the 3586C cycles through the frequency list at the prescribed time intervals.

When the system is in the automatic data acquisition mode, it is advisable to turn off the monitor power. This will decrease wear of the CRT of the monitor.

### 3.4.3 Replacing a Data Disk

If storing data on a hard disk, you may need to move files to a floppy disk for analysis on another computer. To do this, first exit the PCVLF.EXE program (use the

*Escape* key). Then use DOS commands or a file management program to copy and delete the desired files. When finished transferring files, the program may be resumed. Start PCVLF by rebooting the computer, or start the program with keyboard commands. This usually involves

1. change directory to PCVLF,
2. enter the command, PCVLF, and
3. press the "C" key to start data acquisition.

If storing data on a floppy disk, you might wish to replace the disk for a variety of reasons. Change the disk if the program has stopped because the disk is full. Replace the disk if the disk space is approaching zero percent. You also may want to replace the disk to separate one set of data from another. Do the following to replace a disk:

1. Press the *Escape* key to stop data acquisition,
2. If the accuracy of the time displayed on the main menu is not within tolerance, then
  - a. exit the program by pressing *Escape*,
  - b. use the DOS "TIME" command to reset the clock,
  - c. type the "PCVLF" command to restart the program,
3. Write the appropriate label information on the disks,
4. Insert the new disk into the data disk drive,
5. With the main menu displayed on the screen, press the "C" key, and
6. Observe the program is collecting data properly (see Section 3.4.2).

### **3.5 PLOTTING DATA FROM DISK**

The PCVLF program focuses on data collection, rather than data calibration or analysis. However, the program does provide a plotting option from the main menu to allow graphic viewing of the data files (figure 3-15). All three types of data files can be plotted: frequency list data files (figure 3-16), 2-kHz spectrum files, and 200-kHz wide spectrum files.

You can select plotting scales from 10-dB full scale (1 db per division) to 150-dB resolution. When plotting frequency list files you can select up to two channels to view at a time. To plot only one channel, enter zero for one of the channel numbers to be plotted.

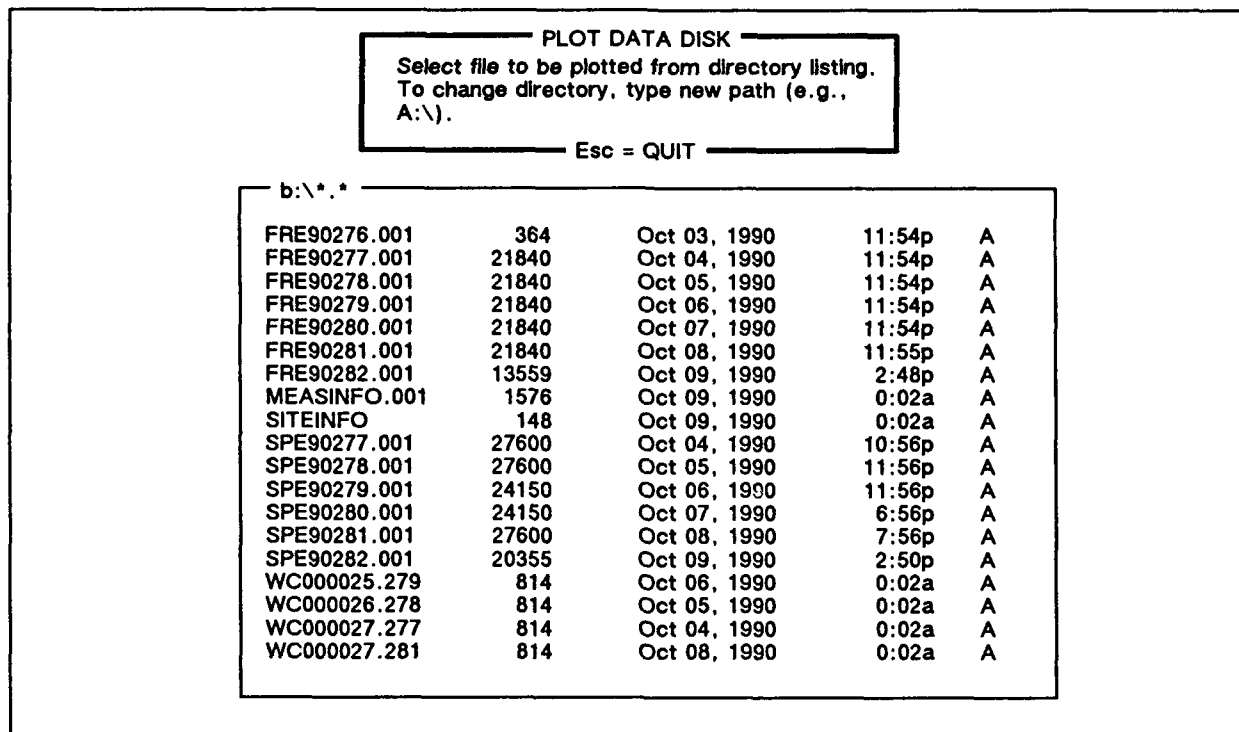


Figure 3-15. Example of disk plot directory listing.

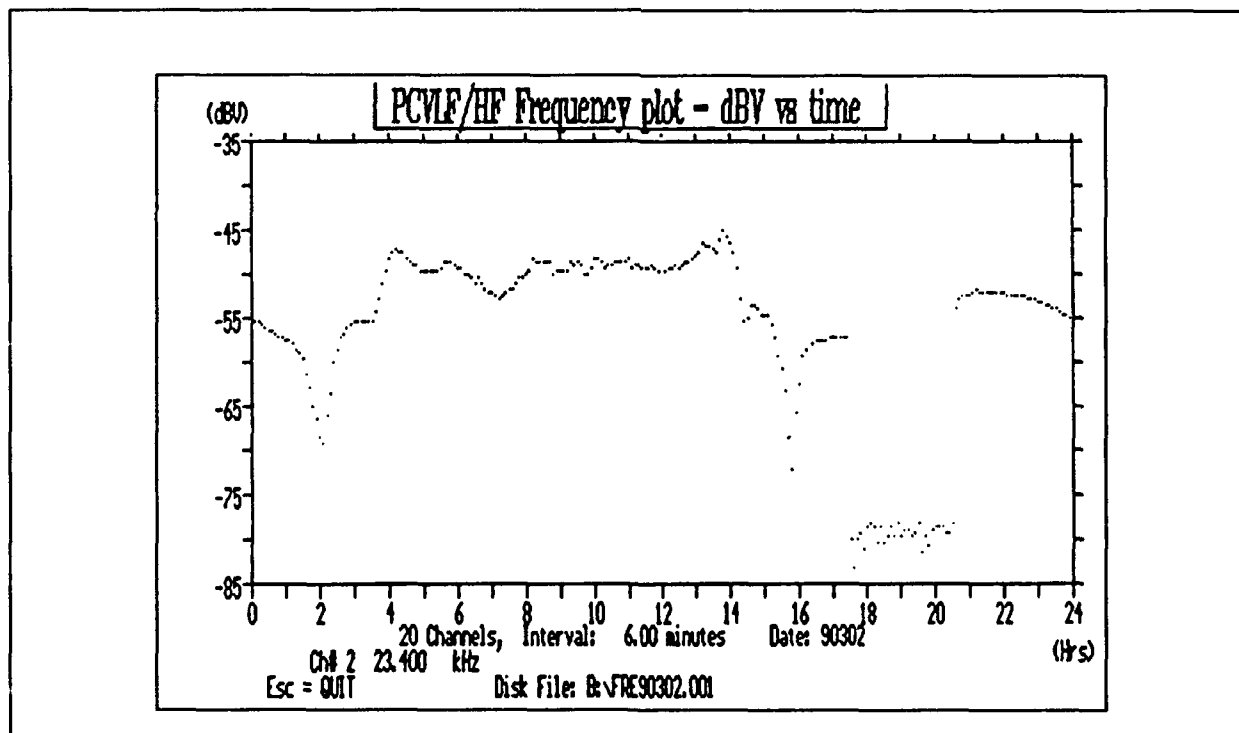


Figure 3-16. Disk plot of frequency list file.

Select the *Plot Disk Data* option from the main menu by pressing the “P” key. Or, highlight the option and press *Enter*. After making the selection, PCVLF prompts you to enter the disk drive letter of the data disk. After entering the drive letter (e.g., A), PCVLF displays a directory listing of that drive. Use the arrow keys to highlight the file to be plotted. Then press *Enter*. The files appear in alphabetical order by file name. To change the order of the listing, press

*Alt-O* to reverse the order,

*Alt-T* to list in time/date order,

*Alt-E* to list alphabetically by file extension,

*Alt-D* to display in same order as DOS directory listing, or

*Alt-N* to restore list order to alphabetical by file name.

## **4.0 REFERENCE SECTION**

### **4.1 SYSTEM EQUIPMENT DESCRIPTION**

The primary components for data acquisition are a computer, an AT-GPIB interface card, and a HP 3586C Selective Level Meter. Additionally, one or two switches may be added to the system. Switches allow selection of input sources or application of output signals. You may want to periodically inject a signal into an active antenna to check gain stability. Or you may wish to switch between several input antennas. Usually an active antenna is the input device to the selective level meter. Appendix A contains diagrams of some typical system wiring configurations.

#### **4.1.1 Computer/AT-GPIB Interface**

Any IBM AT compatible computer that has an expansion slot suitable for a National Instruments AT-GPIB interface card is acceptable for data acquisition. The computer must run MS-DOS version 3.0 or higher, and it must have graphics capability. Installation of the AT-GPIB interface card allows the computer to communicate with the 3586C Selective Level Meter and the 59307A switches. Install the AT-GPIB card with the factory default settings. Also, use the factory default configuration for the GPIB.COM driver program. Refer to the National Instruments support manuals and software for installing and troubleshooting the interface card.

#### **4.1.2 HP 3586C Selective Level Meter**

The HP 3586C Selective Level Meter is a frequency selective voltmeter. The frequency range is 200 Hz to 32 MHz with a measurement bandwidth of 20, 400, or 3100 Hz.

The amplitude accuracy is plus or minus 0.20 dB for levels above -95 dbv when you select a 10-dB range setting. The accuracy using the 100-dB range is plus or minus 2 dB. Stability evaluation of the 3586C indicates readings are repeatable within 0.2 dB at room temperature. The PCVLF measurement accuracy can be improved by doing an external calibration. Because the HP 3586C is so stable (within 0.2 dB), the accuracy of the external calibration system primarily determines the PCVLF measurement accuracy. For example, the field strength accuracy is 0.7 dB when using an external field calibration system accurate to 0.5 dB. Usually, the external calibration system is a calibrated field strength meter and a loop antenna.

The dynamic range of the 3586C is better than 70 dB. Thus, as long as signals to the input are not more than 70 dB apart, they will not add intermodulation distortion to the measurement. It is wise, therefore, not to try to measure very weak signals in the presence of very strong signals without prefiltering.

The 3586C uses a HPIB interface bus to receive setup information from the computer and to return readings to the computer. The PCVLF program assumes the 3586C address is 16. Refer to the installation section for information on verifying address switches. Refer to the manufacturer's operating and service manuals for further specifications and application information.

#### **4.1.3 HP 59307A VHF Switches**

The HP 59307A is two separate switches in one box. Each switch, "A" and "B," is a four pole rf switch. The positions are computer controllable. The positions are "A1" through "A4," and "B1" through "B4."

The switching response time is the computer execution time (estimate 5 ms) plus the relay response time (20 ms). The isolation between contacts is 40 dB. The current rating of the contacts is 0.5 amp at 25 volts.

A common use of the 59307A is to inject a test signal into the active antenna to verify system stability. The same switch also can select from up to four input sources (usually antennas). Installing a second switch allows more possibilities. Since the switch position for each channel can be selected by the user, a large variety of uses and wiring configurations are possible. For example, it is possible to connect both dual switches in parallel and provide up to 12 antenna input selections.

The 59307A switches communicate with the computer via the HPIB interface bus. Unlike the 3586C, the 59307A cannot send messages (talk) to the computer. It can only receive instructions (listen).

The PCVLF.EXE program will support zero, one, or two switches. The address of the first switch (i.e., calibration switch) is 17. The address of the second switch (i.e., antenna switch), if used, is 18. Refer to the installation section for instructions for setting switches.

**4.1.3.1 Calibration Signal/Antenna Select Switch.** The first switch (address 17) usually injects signals from the rear of the 3586C into the active antenna. This checks the antenna preamplifier for drift. The PCVLF.EXE program allows you to schedule zero to 24 of these calibrations per day. Calibration measurements use the "CAL" switch settings previously defined. A calibration measurement first takes a reading of the regular frequency list. This is immediately followed by a 200-kHz spectrum measurement.

Since the user selects each switch position, it is possible to inject a calibration signal during the regular frequency list readings. Do this by choosing the "DATA" switch settings that inject a calibration signal.

**4.1.3.2 Antenna Select Switch.** Sometimes an application requires a second 59307A switch (address 18) for choosing among several antennas. You can activate a second

switch when you set up the measurement schedule. You determine the switch positions for each channel when creating the frequency list.

#### **4.1.4 Antenna-Preamplifier**

The PCVLF.EXE program reads voltage levels from the HP 3586C Selective Level Meter. You can connect any acceptable input device to the 3586C. Usually, an active antenna is the input device. Any antenna that meets your needs and is compatible with the 3586C input (i.e., matches one of the 50-, 75-, or 10-k ohm input impedances) can be used.

## **4.2 TYPES OF MEASUREMENTS**

PCVLF provides several scenarios of automated measurements. The primary measurement is the frequency list measurements. Frequency list measurements can be supplemented with calibration measurements, and 2-kHz spectrum measurements. PCVLF also provides manually controlled measurements.

### **4.2.1 Frequency List Measurements**

The main purpose of PCVLF is to provide periodic measurements of a list of frequencies. You may enter any number of frequencies from one to 60. A channel can be set to any frequency from 1 kHz to 32 MHz. The same frequency can be used more than once. For example, you might want to assign the same frequency to several channels, having each channel switched to a different antenna. During data acquisition PCVLF reads the amplitude value for the frequency assigned to each channel. Readings repeat at time intervals previously defined. PCVLF takes one reading of each channel until each channel in the list has been read. The data values are rounded to 0.1 dB and stored to disk.

You determine how often the measurement sequence repeats when setting the measurement conditions. The default interval is 6 minutes. Measurement intervals can range from 0 seconds to 24 hours. If you entered 0 (minutes or seconds), PCVLF makes continuous measurements without reference to the computer clock. Each new set of readings immediately follows the previous set. A selection of any time other than zero causes the measurements to be synchronized to the clock. For example, if you selected a "1 minute" interval, each measurement starts at the beginning of each new minute detected on the computer's clock. However, PCVLF will not interrupt measurements already in progress. It is up to you to select time intervals that make sense for the desired task. Each channel takes about 3 seconds to measure when averaging is on, and about 1 second without averaging. Thus, it will take about 3 minutes to make one measurement of 60 channels. In this example, if you had selected a measurement period of less than 3 minutes, many periods will be skipped.

You have great flexibility in entering measurement conditions for each frequency. In a typical measurement scenario, you might enter 20 channels to be measured at 6 minute intervals. You can set each channel to any frequency, switch setting, bandwidth, or amplifier dB range. You can select readings with or without averaging.

Figure 4-1 shows a sample list of 10 frequencies and settings. The frequencies in this example are all VLF frequencies. Notice the user set the measurement bandwidth to 400 Hz for most frequencies, but decided to measure the fifth channel at 20 Hz. Each channel can be set to any frequency, even if it duplicates one already in the list. In this example the calibration switch uses the "A1B1" positions for all "Cal" readings. The regular measurements that occur every 6 minutes and use the "Dat" switch settings. The "Dat" switch settings for channels nine and ten are "A1B1." The "A1B1" position could be wired to inject a calibration signal. This example shows a small sample of the variations and control PCVLF affords the user over each reading.

Main Menu    New List    Append    Insert    Delete    Edit    Show List								
CURRENT EQUIPMENT SETTINGS								
Ch	Freq (kHz)	BW	Term	Rng	Avg	Cal	Dat	Ant
1.	21.400	400	50	10	ON	A1B1	A3B3	A1B1
2.	23.400	400	50	10	ON	A1B1	A3B3	A1B1
3.	24.000	400	50	10	ON	A1B1	A3B3	A1B1
4.	24.800	400	50	10	ON	A1B1	A3B3	A1B1
5.	24.800	20	50	100	ON	A1B1	A3B3	A1B1
6.	28.500	400	50	10	ON	A1B1	A3B3	A1B1
7.	53.000	400	50	10	ON	A1B1	A3B3	A1B1
8.	63.000	400	50	10	ON	A1B1	A3B3	A1B1
9.	21.400	400	50	10	ON	A1B1	A1B1	A1B1
10.	63.000	400	50	10	ON	A1B1	A1B1	A1B1
Esc = quit, PgUp   PgDn   Home   End = scroll pages								

Figure 4-1. "Show List" display of frequencies and settings.

PCVLF assigns a coded name to each file containing the frequency list data. The naming convention is: "FRE" followed by the Julian date and a file extension index number (e.g., FRE90359.001). The index number (e.g., 001) has a corresponding file extension index in a MEASINFO file (e.g., MEASINFO.001). MEASINFO is a text file containing the instrument settings and schedule information. PCVLF creates a new FREyyddd.### file at the start of a new Julian date. PCVLF also creates a new

FREyyddd.### file whenever the user changes any measurement conditions, such as the frequency list, measurement times, or instrument settings.

Many applications of the “frequency list measurements” are possible. Past uses of PCVLF and other similar programs include

- monitoring signal variations of vlf transmitters,
- measuring amplifier frequency response,
- comparing signal direction of arrival characteristics,
- comparing atmospheric effects common to hf and vlf signals,
- measuring signal-to-noise characteristics,
- making spectrum analysis, and
- comparing performance of a variety of antennas.

The system has been used on a wide range of platforms, such as land sites, ships, submarines, aircraft, and automobiles.

#### **4.2.2 Calibration Measurements**

Besides the regular frequency list measurements, you may want to check amplifier stability, frequency response, or signal-to-noise of a 200-kHz spectrum. The calibration measurement option allows the regular signal strength measurements of the frequency list to be replaced periodically by measurements that accomplish these special requirements.

The PCVLF.EXE program allows you to choose a period for calibration measurements of zero to 24 times per day. The measurement always begins at the top of the hour. If the program has not finished a regular measurement when the scheduled hour begins, the calibration will be missed. Therefore, it is important that you plan measurement times carefully so regular measurement times don't overlap and cause calibration measurements to be skipped.

Calibration measurements have two parts. First, PCVLF takes a measurement of the frequency channel list. A 200-kHz spectrum measurement immediately follows the channel list measurement. The calibration frequency list measurement differs from the regular frequency list measurements by using a different switch position. Calibration measurements of the frequency list use the “Cal” switch positions instead of the “Data” switch positions. The other measurement settings, such as bandwidth, range, etc., remain the same. If you desire, the same switch positions can be set for both “Cal” and “Data” measurements. This has the effect of adding 200-kHz spectrums to

the measurement scenario without affecting the other measurements. When choosing the instrument settings for 200-kHz spectrum measurements, you can select any center frequency and "Cal" switch setting appropriate to your purposes.

PCVLF does not store the calibration frequency list data in a separate file. It stores calibration data with the regular frequency channel data (i.e., the files prefixed by "FRE"). Although PCVLF stores the calibration data among the regular frequency list data, it stores each 200-kHz spectrum in a separate file. Each file whose name begins with "WC" contains a 200-kHz calibration spectrum. The complete file name is "WC" followed by the time in hours, minutes, seconds and a file extension of the day of the year (format: WChhmmss.ddd). For example, a file named "WC120029.359" means PCVLF stored a 200 kHz calibration at 12:00:29 on day 359 of the current year.

#### **4.2.3 2-kHz Spectrum Measurements**

If you selected "YES" for the 2-kHz spectrum option when setting up the measurement scenario, PCVLF will measure a spectrum of each channel in the frequency list four times a day. PCVLF makes spectrum measurements in the intervals between the regular frequency list measurements. Each spectrum measurement takes about 4.5 minutes to complete (with averaging on). Thus you cannot choose to do spectrums unless there is at least 4.5 minutes of dead-time between regular frequency list measurements. For example, a data acquisition format of 20 channels and a 6-minute interval allows sufficient time for spectrums between regular measurements. One spectrum measurement follows each regular frequency list measurement until PCVLF measures each channel.

The spectrum measurement sequence begins at even 6-hour intervals (i.e., 0000, 0600, 1200, and 1800). The start time advances 1 hour each day. For example, 2-kHz spectrums start at 0100, 0700, 1300, and 1900 on the second day of measurements. The 1-hour advancement of the spectrum cycle circumvents interference from noise sources (e.g., rush hour traffic) that occur at the same time each day.

The 2-kHz wide spectrum consists of 81 readings in 25 Hz steps. The start frequency is 1 kHz below the assigned channel frequency and the stop frequency is 1 kHz above the channel frequency. The settings of the HP 3586C Selective Level Meter are 20-Hz bandwidth and 100-dB range during spectrum measurements.

Although measuring each 2-kHz spectrum separately, PCVLF stores the data for each Julian day in one file. When completing a spectrum measurement, PCVLF appends the data to the existing data for that day. Spectrum file names begin with the letters "SPE" followed by the Julian date. The file extension is an index number corresponding to the index number of the "MEASINFO" file. The MEASINFO file contains the frequencies and measurement settings. For example, the text file MEASINFO.001

lists the settings for the SPE90359.001 spectrum data file. You can plot SPE files to the display using the "Plot Data" selection of the PCVLF.EXE main menu.

#### **4.2.4 Manual 200-kHz Spectrum Measurements**

Manual 200-kHz spectrums empower you with useful signal evaluation tools. The 200-kHz spectrum is handy for finding out which stations are on the air. It is also useful for measuring background noise levels, signal-to-noise levels, and amplifier frequency response.

You can choose among three types of instrument settings for manual 200-kHz measurements. You can manually set the 3586C front panel push-button switches. Or you can have PCVLF set the 3586C switches automatically as you have predefined them. You can choose either the predefined "Data" or "Cal" settings. You can define the center frequency, switch positions, and other settings from the main menu. Select "Schedule Measurements" from the main menu. Then choose "200-kHz Spec" from the menu bar at the top of the screen. The 200-kHz data entry panel will appear.

When using manual settings, the program prompts you to enter two lines of text to label the graph. Then you enter center frequency, and graph scales. Immediately after you complete the entries, the program begins reading values in 500-Hz steps and plotting each value to the screen. When using the predefined "Data" or "Cal" settings, the program collects the 400 readings before plotting the data to the screen.

#### **4.2.5 Manual Frequency List Measurements**

A manual frequency list measurement is a useful tool for evaluating the performance of the system. Make manual frequency list readings by first selecting "Verify Setup/Make Manual Measurements" from the main menu. Then select "Read Freqs" from the menu bar. PCVLF will make an amplitude reading of each channel of the frequency list, and display the value. The display represents the actual ASCII characters returned from the level meter when using the "Use Front Panel Sets" option. A letter, either "N" (normal), "U" (underload), or "O" (overload) precedes the dbv value. The letter signifies the range of the signal compared to the dynamic range of the instrument input and IF amplifiers. When using the "Use Program Sets" or "Use Data Sets" option, the display presents the data as it would be stored to disk. PCVLF rounds the values to 0.1 dB and omits the N, U, or O letter prefixes.

### **4.3 DISK FILES**

There are two categories of disk files, program disk files and data disk files. The program disk contains several files needed to run PCVLF. The data disk contains files of data values and supplementary files that provide information about the data.

### 4.3.1 Program Disk

The program disk contains the main program file, PCVLF.EXE, and supplemental files that PCVLF.EXE needs for its functions. Figure 4-2 contains a list of most of the files contained on in the PCVLF program disk directory. The program disk can be either a floppy disk (separate from the data disk), or a hard disk. If using a hard disk, the installer usually stores program files in a subdirectory, and stores the AUTOEXEC.BAT and CONFIG.SYS files in the root directory.

PCVLF.EXE	The main program, a DOS executable program file that must be present in the current directory.
GPIB.COM	National Instrument's interface device driver needed to communicate with the Hewlett Packard Instruments.
CONFIG.SYS	A DOS file containing device drivers and setup statements that are loaded when the system is booted from DOS.
AUTOEXEC.BAT	A DOS batch (script) file that is automatically executed after the computer is booted. This file is often used to make the PCVLF.EXE start automatically after ac power failures.
SITEINFO	A user created text file that PCVLF stores to each data disk.
CUR_CTRL.CFG	A binary file created by PCVLF.EXE when the user enters schedule, plot channels, data drive, switch use information, etc. PCVLF reads this file before collecting data.
CUR_SETS.CFG	A binary file created by PCVLF.EXE that contains the frequency list and instrument settings assigned by the user for each channel in the list. PCVLF reads this file before collecting data.
(printer files)	GRAFPLUS, or WordPerfect's GRAB.COM are memory resident screen capture programs the user may want to add to the program disk to make hard copies of screen plots.

Figure 4-2. Program disk files.

### 4.3.2 Data Disk

The data disk contains data files and data information files. An information file, SITEINFO, is a text file created by the user. It contains any supplementary information entered by the user, such as address of the site, equipment serial numbers, etc. The supplementary file, MEASINFO.001, is an ASCII text file created by the PCVLF program. It contains frequencies, schedule, and other measurement details needed to interpret the data files. Files whose names begin with "FRE," "W," or "SPE" hold the

actual signal amplitude data for the frequencies listed in the MEASINFO file. FRE files contain the frequency channel list data. WC and WM files contain 200-kHz spectrum data. SPE files contain the 2-kHz spectrum data. The following paragraphs describe the data storage format for each file type.

**4.3.2.1 MEASINFO.###—Measurement Settings.** The MEASINFO files contain all the measurement conditions and equipment settings related to the data files. Each data file (i.e., files beginning with “FRE” or “SPE”) has a corresponding MEASINFO file. The three-digit file extension of the data file has a matching MEASINFO file extension. For example, the text file MEASINFO.001 contains the frequencies and settings corresponding to the data files FRE90359.001, SPE90359.001, FRE90360.001, and any other data files ending in “.001.”

Figure 4-3 shows a sample MEASINFO file listing. All 20 of the frequencies in this example are VLF frequencies. The first number in the file, 90226154402, is a serial number for the file. It represents the date and time when the user originally established (or modified) the settings. After the serial number, the first line contains

- the number of frequency channels,
- acquisition time interval,

90226154402, 20 CH, 6.00 minutes Adu: 16, 17, -1, Cals: 2 SpecON					
WideSpec CF: 100 kHz T1A0B2R2M1F1U2 A1B3A1B3A1B1 DR: C:\					
1.	FR	21.400KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A1B1	A1B3 A1B1
2.	FR	23.400KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A1B1	A1B3 A1B1
3.	FR	24.000KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A1B1	A1B3 A1B1
4.	FR	24.800KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A1B1	A1B3 A1B1
5.	FR	26.000KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A1B1	A1B3 A1B1
6.	FR	28.500KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A1B1	A1B3 A1B1
7.	FR	53.000KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A1B1	A1B3 A1B1
8.	FR	63.00KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A1B1	A1B3 A1B1
9.	FR	21.400KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A1B1	A1B1 A1B1
10.	FR	63.000KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A1B1	A1B1 A1B1
11.	FR	21.400KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A2B2	A2B3 A1B1
12.	FR	23.400KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A2B2	A2B3 A1B1
13.	FR	24.000KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A2B2	A2B3 A1B1
14.	FR	24.800KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A2B2	A2B3 A1B1
15.	FR	26.000KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A2B2	A2B3 A1B1
16.	FR	28.500KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A2B2	A2B3 A1B1
17.	FR	53.000KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A2B2	A2B3 A1B1
18.	FR	63.000KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A2B2	A2B3 A1B1
19.	FR	21.400KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A2B2	A2B2 A1B1
20.	FR	63.000KHT1A1B2R1M1F1U2	T1A1B1R2M1F1U2	A2B2	A2B2 A1B1

Figure 4-3. Typical listing of a MEASINFO.001 file.

- device addresses,
- number of calibration measurements per day (2 in this example), and
- whether 2-kHz spectrum measurements were made.

A device address of -1 (as for the second switch in the example) means the user did not select the device for use. The second line contains 200 kHz spectrum settings center frequency (100 kHz), 3586C instrument commands, switch positions (Cal A1B3, Data A1B3, and Antenna A1B1). The second line also lists the data disk drive (C:\). The remaining text lines are the instrument settings for each channel. For example, channel number one contains the 3586C instrument settings for regular frequency measurements of "FR 21.400KHT1A1B2R1M1F1U2." The 2-kHz spectrum instrument settings are "T1A1B1R2M1F1U2." The Cal, Data, and Antenna switch selections "A1B1 A1B3 A1B1" respectively.

Figure 4-4 lists many of the 3586C instrument commands. The list is helpful for understanding the information contained in the MEASINFO file. For further details on instrument commands, refer to the manufacturer's operating manual.

FR 21.400KH	Sets instrument to 21.4 kHz
T1, T2, T3, T4	Set input termination 50 ohm, 75 ohm, 10 kohm (50 ohm ref.), or 10 kohm (75 ohm ref.)
A0, A1	Averaging Off, On
B1, B2, B3	Bandwidth 20 Hz, 400 Hz, 3100 Hz
R1, R2	Signal Detector Range 10 dB, 100 dB
M1, M2	Low Distortion, Low Noise
F1, F2	Automatic Scaling, User Entry Scale
U1, U2, U3	Units dbm, dbv, dB 0.775 volt

Figure 4-4. HP 3586C GPIB instrument commands.

**4.3.2.2 FREyyddd.###—Measurement Data.** Files whose names begin with "FRE" contain amplitude data taken during the frequency list measurements. For example, the file FRE91291.001 contains a record of the channel readings of Julian day 91291. Although the data in this file is in ASCII format, it is unreadable by many word processors. This is because many text processor programs cannot read files that are a long stream of characters with no carriage return or line feed characters. The text in these files can be viewed using the DOS "TYPE" or "MORE < " commands.

The format of the data in this file is date, time, and a four-digit representation of each reading. The format assumes the reading is negative unless the first of the four digits is a plus sign. It also assumes a decimal point between the third and fourth digit. For example, consider a reading of four channels. The date and time is 90359 19:21:30 GMT. The amplitude values are -107.6 dbv, -43.2 dbv, +6.4 dbv, and -6.4 dbv. This measurement would appear in the data file FRE90359.001. It would be stored in the format "90935919213010760432+0640064." The first 11 digits are the date and time. The remaining 16 digits are the representation of the four readings. The disk file would contain a continuous repetition of data in this format. The data from each measurement gets appended to the previous data until a new day begins.

You can calculate how many measurements a file contains. To make the calculation, the number of channels and the DOS file size must be known. Each measurement consists of an 11 character (11 byte) date-time prefix, followed by four characters per channel of dbv values. Thus, for 20 channels, use  $11 + 20 \times 4$  bytes = 91 bytes. Divide the file size by 91 to determine the number of measurements contained in the file. You can discover the file size from DOS by using the "DIR" command.

PCVLF uses the data format described above to maintain compatibility with some pre-existing data analysis and plotting programs. To use most commercial engineering or plotting programs, the data probably will need conversion to a different format. Writing a conversion utility program should be easy with the information provided in this section.

**4.3.2.3 SPEyyddd.###—2-kHz Spectrums.** Files whose name begins with "SPE" (e.g., SPE91234.001) contain 2-kHz spectrum data. The digits following "SPE" indicate the Julian date. The Julian date format is year followed by day of year (YYDDD). The file name extension is a number from 001 to 999. This is the index number of the corresponding MEASINFO file. For example, the file "MEASINFO.001" contains the instrument settings and user options for spectrum file "SPE91234.001."

Each spectrum file contains all the 2-kHz spectrum readings recorded on that Julian day. PCVLF appends the measurement data of each spectrum to the existing file. It creates a new file only when the user changes the settings, or when the data falls on a new Julian day.

PCVLF stores "SPE" data in ASCII format, but it may be unreadable by many word processors. Many text processor programs cannot read large files containing no carriage return or line feed characters. The text in SPE files can be viewed using the DOS "TYPE" or "MORE <" commands. The format of SPE files is date, time, and channel number, followed by 81 four digit readings. As in FRE files, the format assumes each four-digit reading is a negative value unless the first digit is a plus sign. Also, the format assumes a decimal point between the third and fourth digit. As an

example, consider a spectrum reading of channel one on day 90359 at 00:06:34 GMT. Assume the first four values in this example are -107.6 dbv, -43.2 dbv, +6.4 dbv, and -6.4 dbv. This measurement would appear in the data file SPE90359.001 as

909359000634CH# 1 10760432+0640064 . . .

The first eleven digits are the date (90935) and time (000634). The next ten digits state the channel number of the center frequency (CH# 1). The next 16 digits represent the first four readings (1076, 0432, +064, 0064). Although this example shows only four readings, the actual file would contain 81 readings. The disk file contains a continuous sequence of all spectrum readings taken on that Julian day. PCVLF appends data from each measurement set to the previous data.

Knowing the number of channels, it is easy to estimate the expected size of a spectrum file. Each measurement consists of a 21 character (21 byte) date, time and channel number prefix, followed by 324 characters of amplitude data (81 readings x 4 characters per reading). Thus, if there are 20 channels, the calculation is

345 bytes x 20 channels x 4 spectrums per day = 27,600 bytes.

PCVLF stores in the format described above to maintain compatibility with existing data analysis and plotting programs. With the information provided in this section, anyone with minimal programming experience can write a utility program to convert the data to another format. For example, a simple conversion utility could reformat the data to be read directly by a commercially available engineering, plotting, and analysis program.

**4.3.2.4 Wchhmmss.ddd—200-kHz Spectrums.** Data files whose names begin with "W" are 200-kHz spectrum files. As mentioned earlier, PCVLF stores FREyyddd.### and SPEyyddd.### data files as ASCII text. However, PCVLF stores WM and WC files (200 kHz spectrums) as binary integers. The file size is 814 bytes. This represents 407 two-byte integers. The first seven integers are year, month, day, hours, minutes, second, and center frequency. The remaining 400 integers are the actual data readings multiplied by 100.

You can plot and print wide spectrum data files from the main menu by using the "plot disk" option. To obtain a hard copy of the plot requires a memory resident printer driver to be installed, such as "Grafplus."

#### **4.4 MEASUREMENT STRATEGIES, PROBLEMS, AND CONSIDERATIONS**

The ability of the PCVLF program to switch input sources allows many hardware configurations. Switching antennas and switching signals on and off makes the PCVLF system useful for many different tests. The capabilities of the HP 3586C Selective

Level Meter determine the limitations of the measurements. Thus, the first consideration in determining a measurement strategy is to consider the capabilities of the selective level meter. Does it have the desired speed, accuracy, range, bandwidth, measurement technique, etc. to accomplish the desired goal? Refer to the Selective Level Meter Operating Manual for specifications and measurement techniques.

Generally, the 3586C is inadequate for measuring rapidly changing waveforms, such as impulse noise or pulse modulated signals. Originally, the intended use of the data acquisition system was to monitor the seasonal propagation effects of continuous wave (CW) and frequency-shift-keyed (FSK) modulated transmissions. However, the system has proved itself useful for a variety of other tests, such as testing amplifiers, measuring radiated power, and comparing antenna systems.

#### **4.4.1 Measurement Suggestions**

When determining a measurement scheme, first verify the equipment is capable of meeting the measurement requirements. Then determine which of the three types of measurements (i.e., frequency list measurements, calibration measurements, and 2-kHz spectrums) to use. Decide how often the measurements need to be repeated. It is important to verify there are no timing conflicts between the various measurements.

Usually, each reading of the 3586C takes about three seconds with averaging on and one second with averaging off. Consider the following as guidelines. One measurement of a 20-channel frequency list takes about 1 minute. A calibration measurement using 20 channels takes about 7 minutes. It takes 1 minute to read twenty channels, plus it requires an additional 6 minutes to measure the 200-kHz spectrum. If you designate PCVLF to do 2-kHz spectrum measurements, each spectrum takes about 4.5 minutes. Remember, plan the time settings to avoid conflicts! Measurements will be skipped if scheduled to begin before the preceding one is finished.

#### **4.4.2 Troubleshooting Problems**

The fifth item of the PCVLF main menu, "Verify Setup/Make Manual Reading," provides a convenient troubleshooting aid. Using this option, equipment communications can be verified and actual readings can be observed. Most equipment problems can be isolated by comparing the values of the manual measurements with the expected results.

Problems can arise even when the hardware and software is functioning normally. For instance, the computer's clock may not have the desired accuracy; the site may have noise interference; or, you may have set measurement intervals that conflict. These kinds of problems require rethinking the problem, and deciding the best course of action. The following is some typical corrective actions. The computer may need an

external clock and a memory resident clock program. The user may need to reset the time whenever replacing disks. The system may need to be moved to a new site. You may need to change the frequency or interval assignments of the program.

If a problem results from a software bug or an error in this manual, please notify the Naval Ocean Systems Center, Ionospheric Branch, Code 542, San Diego, CA, 92152-5000. If possible, provide enough detail that the problem can be replicated.

#### **4.4.3 Data Calibration And Analysis**

The PCVLF program is a data acquisition system. It is not intended for analyzing, calibrating, or printing the data. The program does provide viewing of the data on the display monitor, both in realtime and from the disk. This data viewing capability allows you to evaluate the data in terms of signal-to-noise, waveform comparison, and other relative terms.

Accomplishing extensive data analysis requires other software programs. Furthermore, if the data is to be converted from dbv units to absolute field strength (dB above a microvolt per meter), then the site must be properly calibrated. The site can be calibrated by connecting a known (calibrated) antenna directly to the system. You also can calibrate the system by comparing values measured at the site with measurements taken simultaneously with another calibrated system. In either case, the PCVLF program does not provide a means of adjusting the data values. You must provide other software to analyze and adjust the data.

## **5.0 ABBREVIATED INSTRUCTIONS**

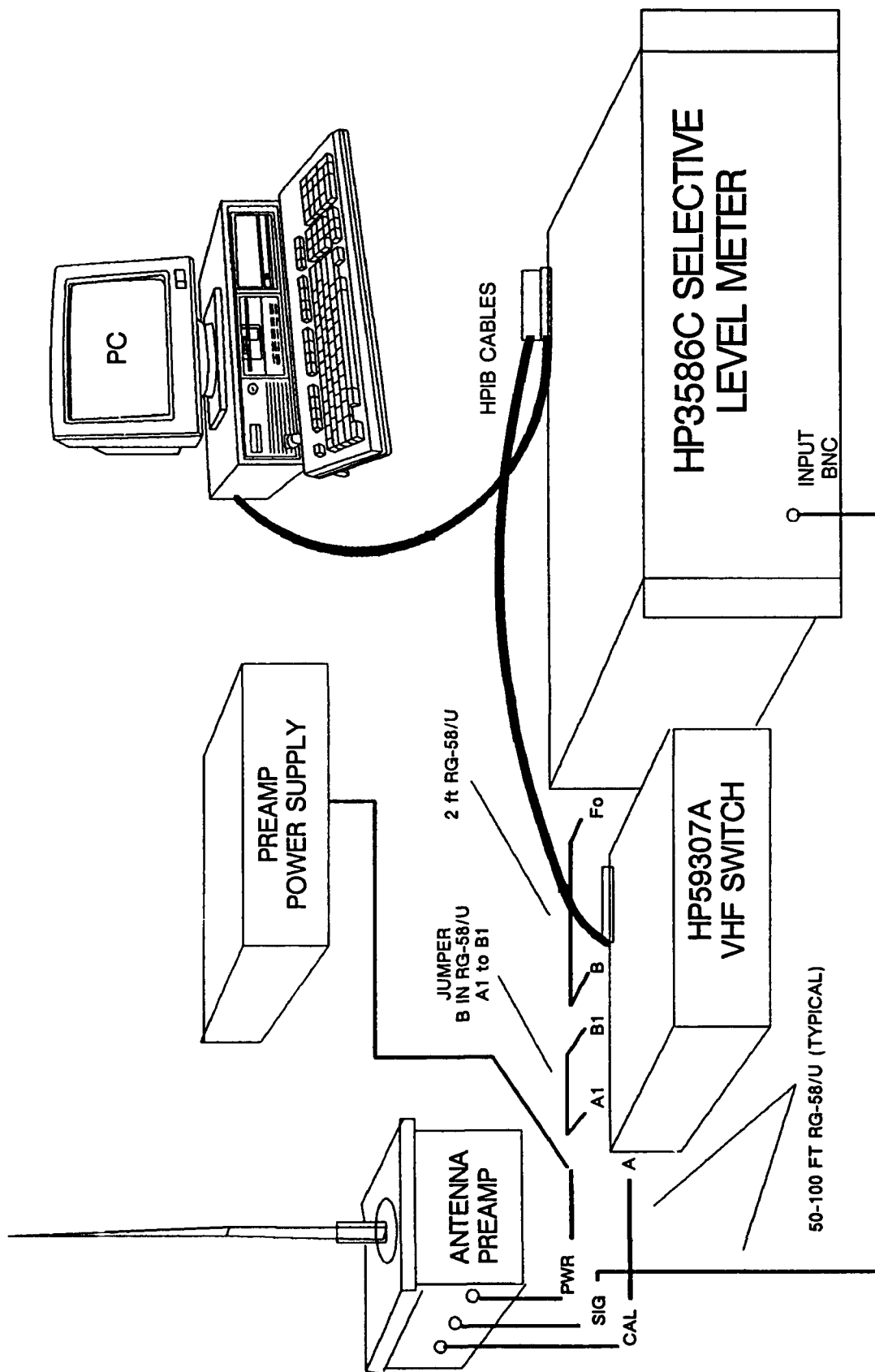
### **5.1 PRELIMINARY SETUP**

1. Install GPIB interface board into the computer using default settings.
2. Load PCVLF.EXE, GPIB.COM onto hard disk.
3. Modify the CONFIG.SYS file to load the GPIB.COM interface device driver (e.g., DEVICE=C:\PCVLF\GPIB.COM).
4. Modify the AUTOEXEC.BAT file to change to the PCVLF program directory (CD C:\PCVLF), and to run program automatically (PCVLF).
5. Check HPIB addresses: HP 3586C address = 16, first HP 59307A address = 17, second HP 59307A address = 18.

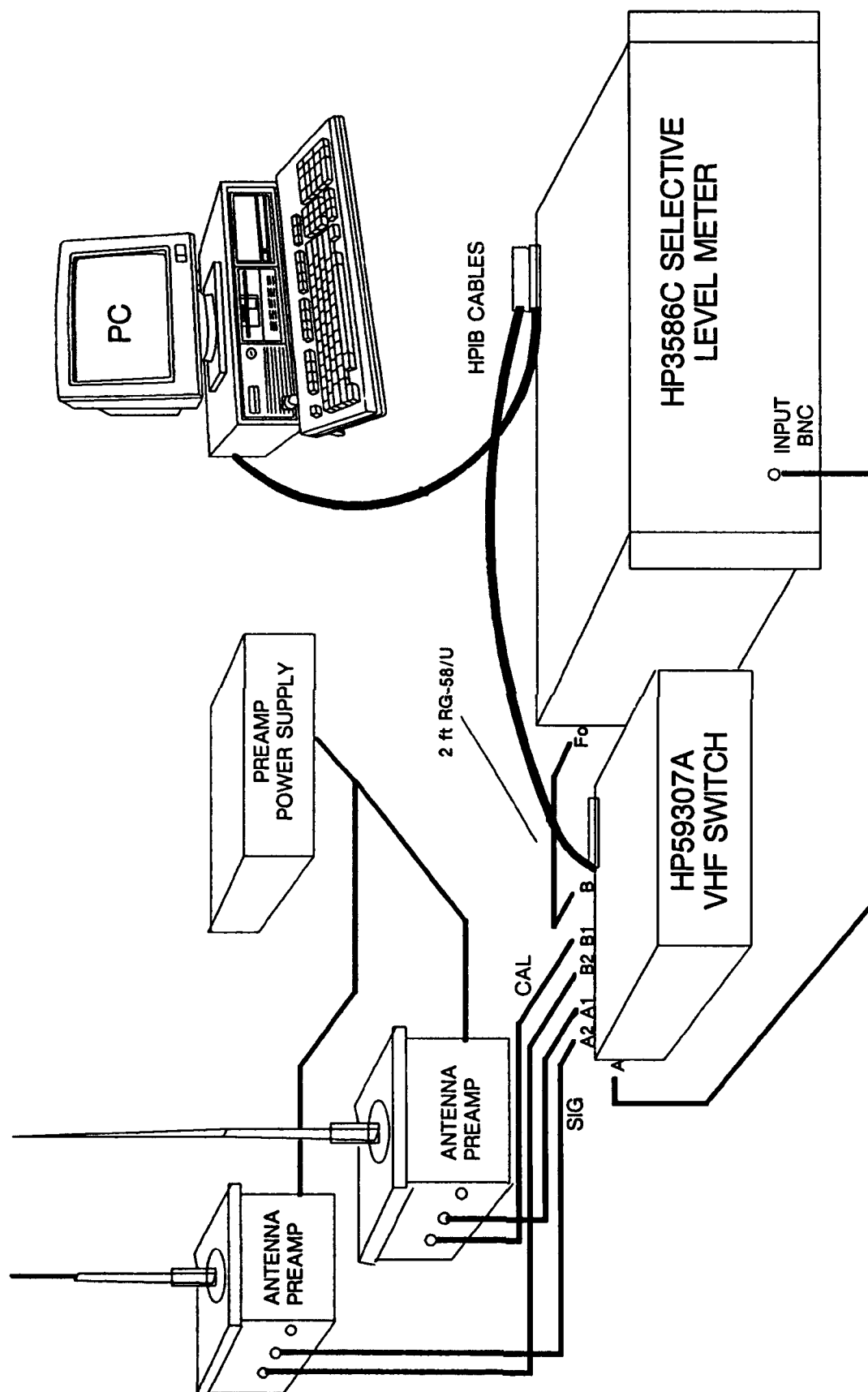
### **5.2 INSTALLATION**

1. Install equipment and connect HPIB cables, ground radials, rf cables, and ac power according to system wiring diagram.
2. Power up system.
3. Select main menu option "Verify Setup/Make Manual Readings."
4. Select "Test HPIB" to verify instrument communications.
5. Select "200 kHz Spectrum" to verify signal-to-noise is acceptable.

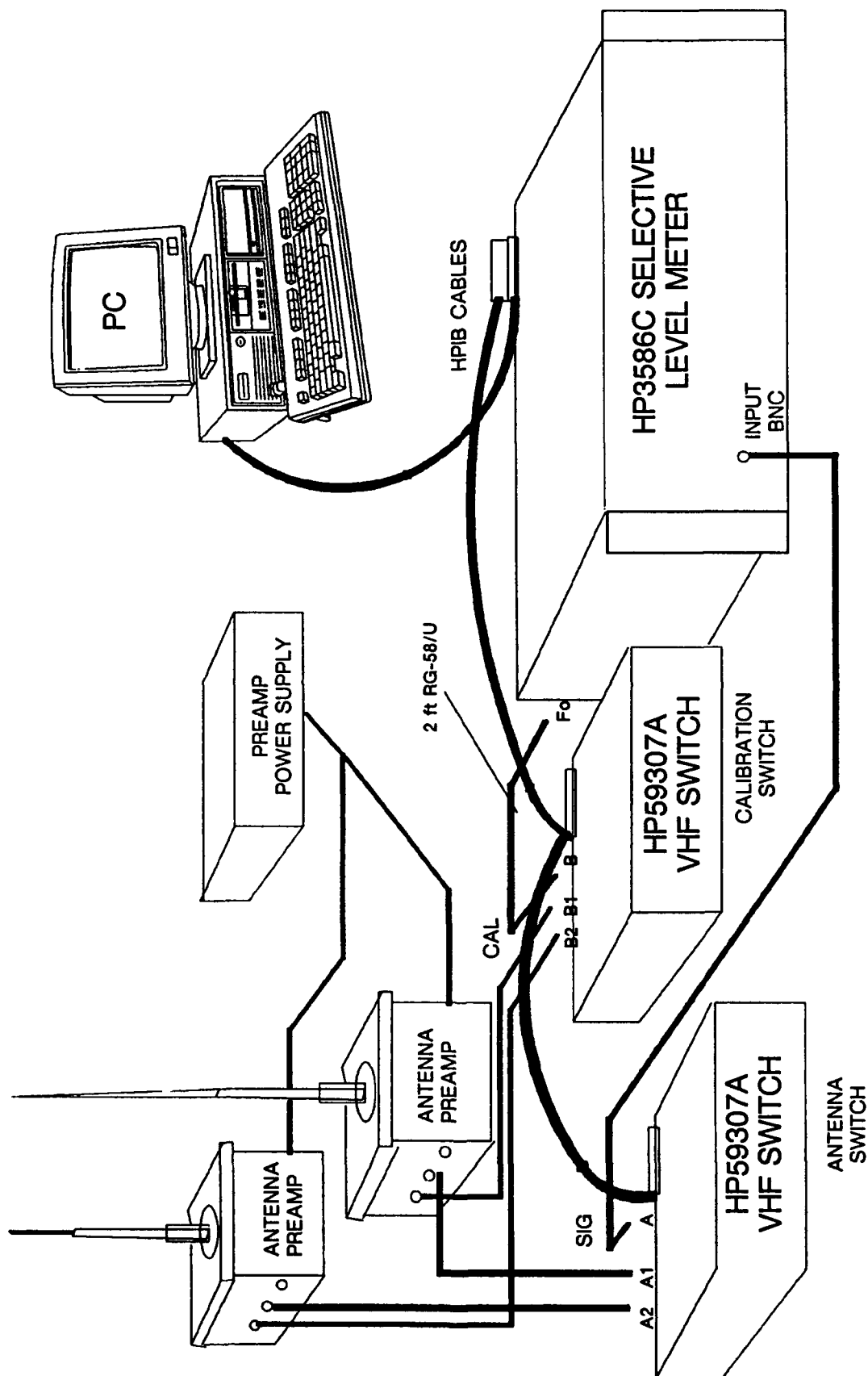
**APPENDIX A**  
**WIRING DIAGRAMS**



Typical configuration using 1 antenna and 1 CAL signal switch.



Typical configuration using 2 antennas and 1 CAL signal switch.



Typical configuration using 2 antennas and 2 CAL signal switches.

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